Vol. XXV, B, No. 3 December, 1955

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Contributors are requested to be clear and concise. Manuscripts should not exceed 8,000 words and should be in a final form for the press. Each paper should start with a short summary which should be an abstract of the whole paper, complete and clear in itself, and not over 3 per cent. of the length of the paper. The introduction and reviews of literature should be restricted to closely pertinent papers.

The manuscript should be typewritten on one side of the paper only, with wide margins and be double spaced throughout including titles, footnotes, literature citations and legends. Symbols, formulae and equations must be written clearly and with great care. Scientific names of genera and species are printed in italics and should be underlined in the typescript. Too many tables, graphs, etc. should be avoided. Each table should be typed on a separate sheet with its proper position marked in the text in pencil.

Literature citations: All references to literature cited in the text should be presented together at the end of the paper in alphabetical order of authors' names. Each reference should be given in a standard form as follows: (1) name(s), followed by initial(s), of author(s); (2) year of publication in brackets; (3) full title of paper; (4) title of journal, abbreviated according to *World List of Scientific Periodicals*, 1952, and underlined; (5) volume number in Arabic numerals, underlined with two lines to indicate bold type; (6) page numbers without the prefix, p. When books are mentioned in the references, the order should be: name of author(s), initial(s), year in brackets, title of the book, which should be underlined, volume number, edition, page, followed by place of publication and name of publisher. Where a reference has not been seen in original, it should be indicated by an asterisk and the name of the abstracting journal or other source should be mentioned in brackets. If the title is in a language other than English, the diacretic signs, etc., should be precisely given as in the original.

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References:

Raman, C. V. (1949) The theory of the Christiansen experiment. *Proc. Indian Acad. Sci.*, A, 29: 381-90.

Sahni, B. (1936a) Wegener's theory of continental drift in the light of Palaeobotanical evidence. *J. Indian bot. Soc.*, 15: 31-32.

Sahni, B. (1936b) The Karewas of Kashmir. *Curr. Sci.*, 5: 10-16.

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J. Madras Univ., B. XXV, No. 3, pages 213-218, 1955

A Study in Fractionation of Castor Oil Methyl Esters by Liquid-Liquid Extraction

BY

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(Received for publication, August 24, 1955)

ABSTRACT

The methyl esters obtained by the methylation of castor oil can be fractionated to get a fraction richer in methyl ricinoleate by means of solvent extraction. In the present paper equilibrium and phase distribution data are presented for the system castor oil methyl esters —furfural—cyclohexane at 30°C. It is observed that the hydroxyl value of the methyl esters in furfural phase was greater than that of the original esters while that of the methyl esters in cyclohexane phase was lower than that of the original esters. The study indicates that the solvents furfural and cyclohexane can be used for fractionation of the mixed methyl esters.

Methylation of castor oil results in the production of methyl esters which are useful in reactions involving ricinoleic acid. The mixed acids from castor oil contain about 87% ricinoleic acid, the rest being oleic, linoleic, dihydroxy stearic, etc. The values obtained for the percentage of ricinoleic acid by the various investigators have been indicated by Bolley (1953). These methyl esters obtained by the methylation of castor oil can be fractionated to get a fraction richer in methyl ricinoleate by means of solvent extraction. McCormack and Bolley (1954) studied the separation of castor oil methyl esters by means of liquid-liquid extraction using a pair of solvents methyl alcohol and heptane at 24°C and 8·4°C. It was observed that the optical activity as well as the hydroxyl value of the esters in the methanol phase was usually greater than that of the original esters while that of the esters in the hydrocarbon phase was less. Preliminary investigations indicated that mixed methyl esters of castor oil distribute themselves in furfural and cyclohexane phases, and furfural phase had a greater affinity towards ricinoleic ester than the cyclohexane phase. In the present paper equilibrium and phase distribution data are presented for the system castor oil methyl esters—

furfural—cyclohexane at 30°C. The two phase region for this system at 30°C is much larger than that for the system castor oil methyl esters—methanol—heptane at 24°C studied by McCormack and Bolley (1954).

Purity of Materials

1. *Castor oil methyl esters*: These were prepared by the methylation of castor oil by the method of Brown and Green (1940). The mixed methyl esters thus obtained had a hydroxyl value of 174·3.

2. *Furfural*: Furfural supplied by Allied Chemical and Dye Corporation, New York, N.Y., was purified by vacuum fractionation. It had a boiling range of 64-65°C at 25 mm. Hg. pressure.

3. *Cyclohexane*: Laboratory reagent grade cyclohexane supplied by the British Drug Houses Ltd., was distilled and the fraction obtained between 80·5° — 81·5°C was used for these investigations.

Experimental Procedure

The equilibrium and phase distribution data were obtained as described by Othmer and co-workers (1941). Known mixtures of the three components, castor oil methyl esters, furfural and cyclohexane, well within the heterogeneous region, were taken in a clean separating funnel. The mixture was agitated and then placed in the constant temperature bath at 30° for a minimum period of three hours until the mixture had separated into two clear layers. The individual phases were, then, separated and weighed. Furfural in each phase was determined volumetrically. Methyl esters in each phase were determined by boiling away cyclohexane and furfural under vacuum and drying the esters to constant weight in a stream of hydrogen under low pressure at a temperature of 110°C. The fraction of methyl esters thus obtained in each phase was also evaluated in terms of hydroxyl value.

Results

The equilibrium data for the system castor oil methyl esters—furfural—cyclohexane are given in Table I along with the hydroxyl value of the methyl esters in each of the furfural and cyclohexane phase. Although it is realized that castor oil methyl esters are not a single component, the results of these investigations are best observed by plotting wt. % castor oil methyl esters against wt. %

TABLE 1.

Equilibrium Tie Line Data for the system Castor Oil Methyl Esters – Furfural – Cyclohexane at 30° C.

Furfural phase composition Weight percent.			Cyclohexane phase composition Weight percent.			Hydroxyl Value of Castor Oil methyl esters in furfural phase.	Hydroxyl Value of Castor Oil methyl esters in cyclohexane phase.
Castor Oil Methyl esters.	Furfural	Cyclohexane	Castor Oil Methyl esters.	Furfural	Cyclohexane		
—	12·16	87·84	—	5·9	94·1	—	—
11·55	76·68	11·77	9·00	9·74	81·26	193·6	157·0
15·92	68·27	15·81	14·63	16·28	69·09	189·8	153·6
20·65	50·55	28·80	19·95	26·14	53·91	188·8	152·9

furfural on cartesian coordinates according to the method of Brown (1950). This has been done in Fig. 1. The two points

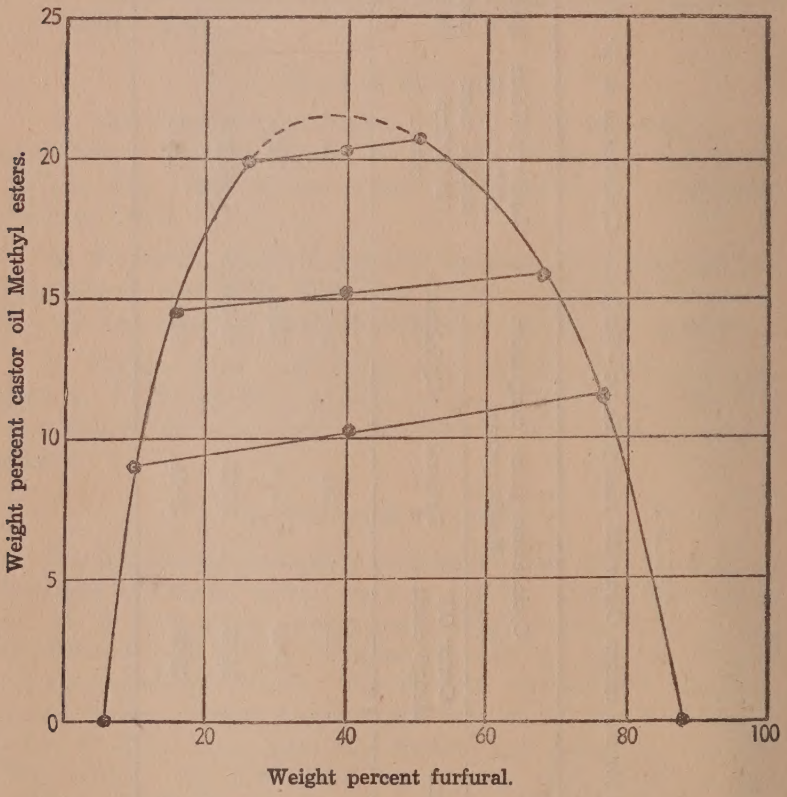

Fig. 1.

representing the compositions of two phases in equilibrium with each other have been joined by the tie line. The points indicated by circles within the heterogeneous curve represent the compositions of initial mixtures separating into two phases.

In Fig. 2 wt. % castor oil methyl esters in furfural phase has been plotted against the wt. % castor oil methyl esters in cyclohexane phase. The curve indicates that the castor oil methyl esters are preferentially distributed in the furfural phase. The curve in Fig. 2 has been extrapolated (dotted) to indicate its general trend in approaching the plait point which must lie on the 45° diagonal line, since the composition of the two phases in

equilibrium must be identical at that point. This corresponds to about 20% castor oil methyl esters as seen in Fig. 2.

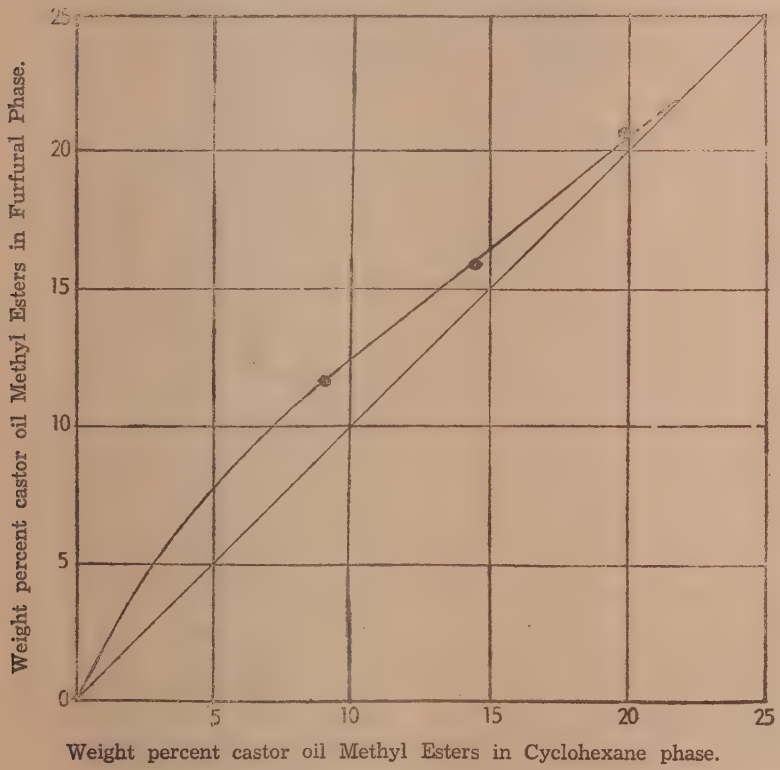

Fig. 2.

It will be observed from the experimental data that when original mixtures corresponding to the constant concentration of furfural (39·87%) and varying concentrations of castor oil methyl esters of 10·38%, 15·31% and 20·65% in the heterogeneous region were allowed to separate into two phases in equilibrium with each other, the hydroxyl value of castor oil methyl esters in furfural phase was much greater than that in the cyclohexane phase in each of the above cases. The hydroxyl value of castor oil methyl esters fractionated in the furfural phase compares favourably with that of pure methyl ricinoleate, the hydroxyl value of which is 185. The study indicates that furfural and cyclohexane can be used as solvents for fractionation of methyl esters of castor oil.

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J. Madras Univ., B. XXV, No. 3, pages 219-226, 1955

Studies in Deacidification of Vegetable Oils

BY

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(Received for publication, August 24, 1955)

ABSTRACT

Investigations on the applicability of solvent extraction process for deacidification of vegetable oils have indicated that ethyl alcohol could be used as the selective solvent for extraction of oleic acid from groundnut oil—oleic acid solutions. In the present paper complete mutual solubility and phase distribution data for the ternary system groundnut oil—oleic acid—ethyl alcohol at 30°C using 90%, 95% and anhydrous ethyl alcohol are given. It is found that increased concentration of water in ethyl alcohol increases the area of immiscibility but tends to decrease the affinity of oleic acid towards ethyl alcohol.

While investigating the applicability of solvent extraction process for extracting fatty acids from fatty acid-vegetable oil solutions, it was found that furfural and acetic acid could be used as solvents for extracting oleic acid from groundnut oil—oleic acid solutions (1955). Further search for solvents has indicated the use of certain aliphatic alcohols. In the present paper solubility and tie line data are reported for the groundnut oil—oleic acid—ethyl alcohol system at 30°C using 90%, 95% and anhydrous ethyl alcohol as solvents. The effect of water present in ethyl alcohol used as solvent on the phase distribution relationship of the ternary system has been indicated. It is, also, observed that the solvents 90% and 95% ethyl alcohol have a good selectivity for the extraction of oleic acid from groundnut oil—oleic acid solutions.

Purity of Materials

1. *Groundnut oil*: Double refined groundnut oil supplied by Mysore Vegetable Oil Products, Madras, was heated to 60°C under an absolute pressure of 5 cm. Hg. and pure dry hydrogen was passed through it for six hours. The purified oil had a free acidity of 0·05%, a saponification value of 191, an iodine value of 94·6 and a density of 0·9100 at 30°C.

2. *Oleic acid:* Laboratory chemicals grade oleic acid supplied by May and Baker was used. It had an iodine value of 96 and a density of 0·8894 at 30°C.

3. *Ethyl alcohol:* Absolute alcohol supplied by Medical Store Depot, Madras, was refluxed with fresh calcium metal turnings for an hour and distilled observing the usual precautionary measures to exclude moisture. The absolute alcohol thus obtained had a density of 0·78075 at 30°C. 95% and 90% ethyl alcohol solutions were made by mixing the calculated amounts of anhydrous alcohol and double distilled water.

Experimental Procedure

All measurements were made at 30°C. A known quantity of groundnut oil was taken in a clean dry weighed flask fitted with a ground glass stopper. To this was added a known quantity of oleic acid and the flask was again weighed. The flask was placed in a thermostat maintained at 30°C for about 30 minutes. The flask was then taken out and the solvent (alcohol) was added from a burette fitted with a calcium chloride tube at the top to prevent moisture from entering inside. After each addition the contents of the flask were shaken vigorously and the flask placed in the thermostat. The solvent addition was stopped when a cloudiness appeared which did not disappear with mixing and the turbidity remained for 20 minutes when the flask was in the bath. The flask was weighed and the amount of solvent added was found out by difference. A second series of mixtures was made up of oleic acid and alcohol. The third component, groundnut oil, was added from the burette. This enabled determinations of mutual solubility data for the whole range of Solubility curve.

Othmer *et al.* had given a procedure for evaluating the phase distribution data (1941). Known amounts of oleic acid, groundnut oil and alcohol were taken in a clean dry weighed separating funnel, such that the over-all composition fell in the heterogeneous region of the mutual solubility curve. The mixture was well agitated and placed in the thermostat for a minimum period of three hours. The two phases were then separated and weighed. Density of each phase was also determined. The composition of each phase was determined with the help of the density *vs* saturated phase composition curve. This was checked with the determination of oleic acid concentration in each layer by direct titration.

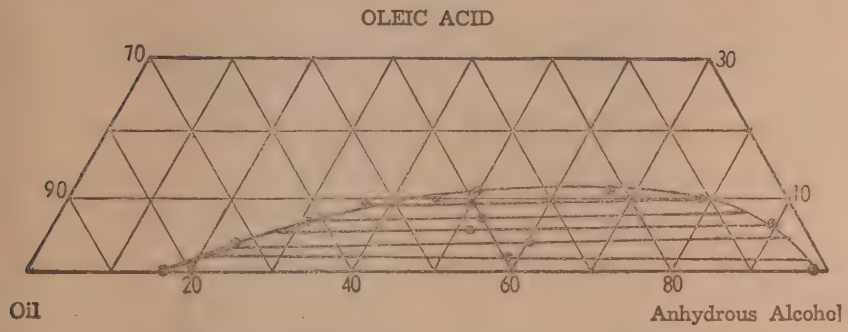

Fig. 1. Solubility curve and Tie lines for the system: Groundnut oil—Oleic acid—Anhydrous alcohol.

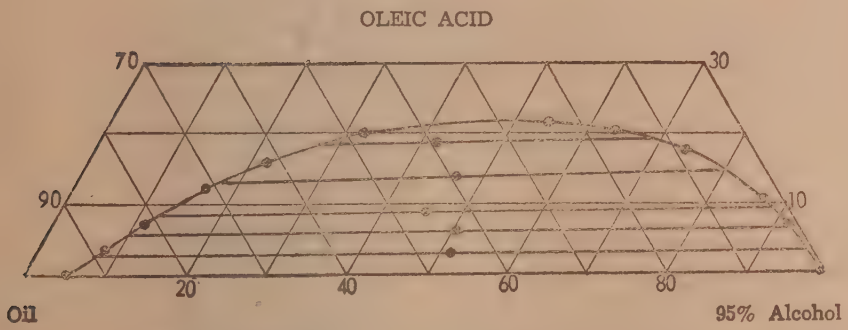

Fig. 2. Solubility curve and Tie lines for the system: Groundnut oil—Oleic acid—95% Alcohol.

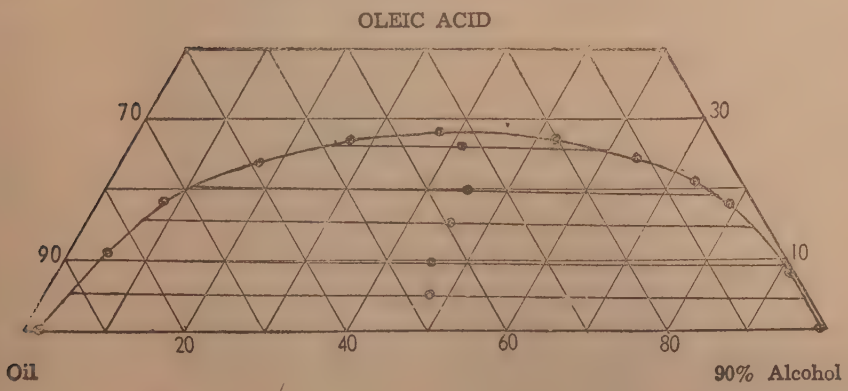

Fig. 3. Solubility curve and Tie lines for the system: Groundnut oil—Oleic acid—90% Alcohol.

TABLE I

Equilibrium Data for the System Groundnut oil—Oleic acid—Anhydrous Alcohol at 30° C.

Solubility Data Weight Percent					
Oleic acid	Oil	Alcohol (100%)	Oleic acid	Oil	Alcohol (100%)
0·0	83·05	16·95	0·0	2·04	97·96
2·75	74·20	23·05	6·35	3·63	90·02
6·95	62·02	31·03	10·50	11·18	78·32
9·14	53·19	37·67	11·45	21·74	66·81
			11·09	38·56	50·35
			10·09	44·59	45·32

Tie Line Data					
Oil Phase Composition Weight Percent.			Alcohol Phase Composition Weight Percent.		
Oleic acid	Oil	Alcohol (100%)	Oleic acid	Oil	Alcohol (100%)
1·93	77·87	20·20	2·43	1·87	95·70
3·60	72·40	24·00	4·37	2·63	93·00
5·60	65·10	29·30	6·64	3·26	90·10
7·22	59·00	33·78	8·29	6·96	84·75
9·49	50·41	40·10	9·95	11·05	79·00

TABLE II

Equilibrium Data for the System Groundnut Oil—Oleic Acid—95% Ethyl Alcohol at 30° C.

Solubility Data Weight Percent.					
Oleic acid	Oil	Alcohol (95%)	Oleic acid	Oil	Alcohol (95%)
0·0	95·02	4·98	0·0	0·4	99·60
3·27	88·56	8·17	6·51	1·57	91·92
6·99	81·30	11·71	10·53	2·26	87·21
12·29	71·20	16·51	17·66	8·38	73·96
15·92	61·92	22·16	20·22	16·24	63·54
19·78	47·46	32·76	21·15	23·90	54·95

Tie Line Data

Oil Phase Composition Weight Percent.			Alcohol Phase Composition Weight Percent.		
Oleic acid	Oil	Alcohol (95%)	Oleic acid	Oil	Alcohol (95%)
2·73	90·00	7·27	3·07	0·73	96·20
5·54	84·46	10·00	6·31	1·00	92·69
8·10	79·20	12·70	9·29	1·91	88·80
12·90	68·77	18·33	14·62	5·38	80·0
18·27	54·48	27·25	19·15	13·15	67·7

TABLE III

Equilibrium Data for the System Groundnut Oil—Oleic Acid—90% Ethyl Alcohol at 30° C.

Solubility Data Weight Percent.					
Oleic acid	Oil	Alcohol (90%)	Oleic acid	Oil	Alcohol (90%)
0·0	98·51	1·49	0·0	0·12	99·88
10·80	84·29	4·91	8·04	0·34	91·62
17·96	73·51	8·53	18·09	2·91	79·00
23·30	59·18	17·52	21·63	5·27	73·10
26·68	45·97	27·35	24·85	11·09	64·06
			26·96	19·96	53·08
			27·76	34·55	37·69

Tie Line Data

Oil Phase Composition Weight Percent.			Alcohol Phase Composition Weight Percent.		
Oleic acid	Oil	Alcohol (90%)	Oleic acid	Oil	Alcohol (90%)
5·09	91·91	3·0	4·64	0·20	95·16
9·96	85·60	4·44	9·18	0·60	90·22
15·43	77·00	7·57	14·76	2·00	83·24
20·30	67·70	12·00	19·36	3·8	76·84
26·50	46·50	27·00	25·68	13·8	60·52

Results

The equilibrium data for the system, groundnut oil—oleic acid—alcohol are presented in Tables I, II, and III for anhydrous alcohol, 95% alcohol, and 90% alcohol and shown graphically in

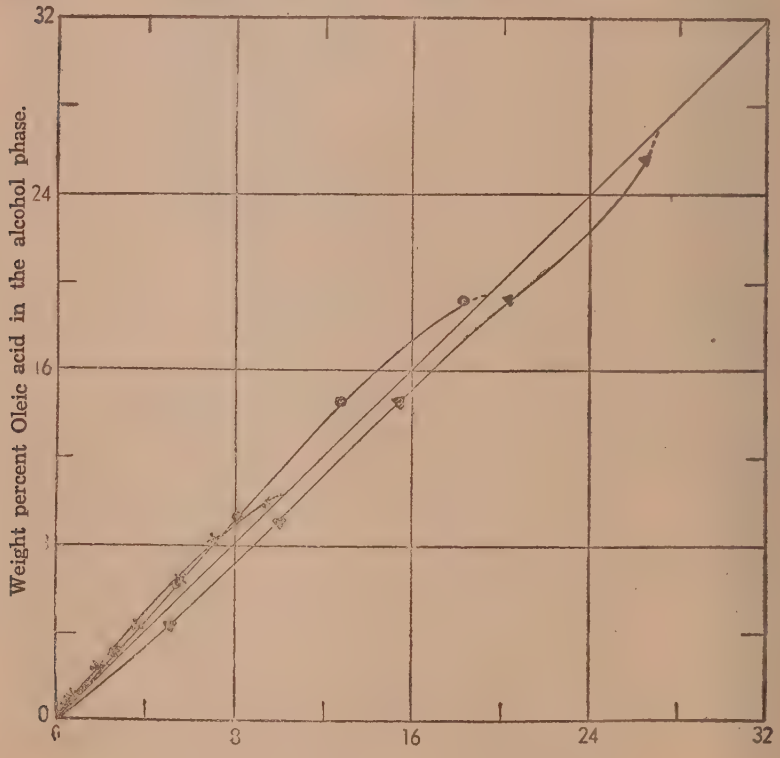

Fig. 4. Distribution of Oleic acid between the oil and the alcohol phases.
× Anhydrous alcohol ⊙ 95% alcohol ▽ 90% alcohol

Figures 1, 2, and 3 respectively. In Figure 4, weight percent of oleic acid in the solvent layer is plotted against the same quantity in the oil layer.

It is seen from Figures 1 and 4 that anhydrous alcohol has got a very low range of applicability. It may also be noted that, while 90% alcohol has a greater range than 95% alcohol, the ratio of oleic acid in solvent layer to that in the diluent layer is greater in the case of 95% alcohol. This is clearly

shown in Figure 4 where the curve corresponding to 90% alcohol lies below the 45° line of equivalence. The curves have been extrapolated (dotted) to indicate their general trend in approaching the plait point which must fall on the 45° diagonal line.

Among the various methods recommended for smoothing and interpolation of phase distribution data, the one suggested by Othmer and Tobias is illustrated in Figure 5 (1942).

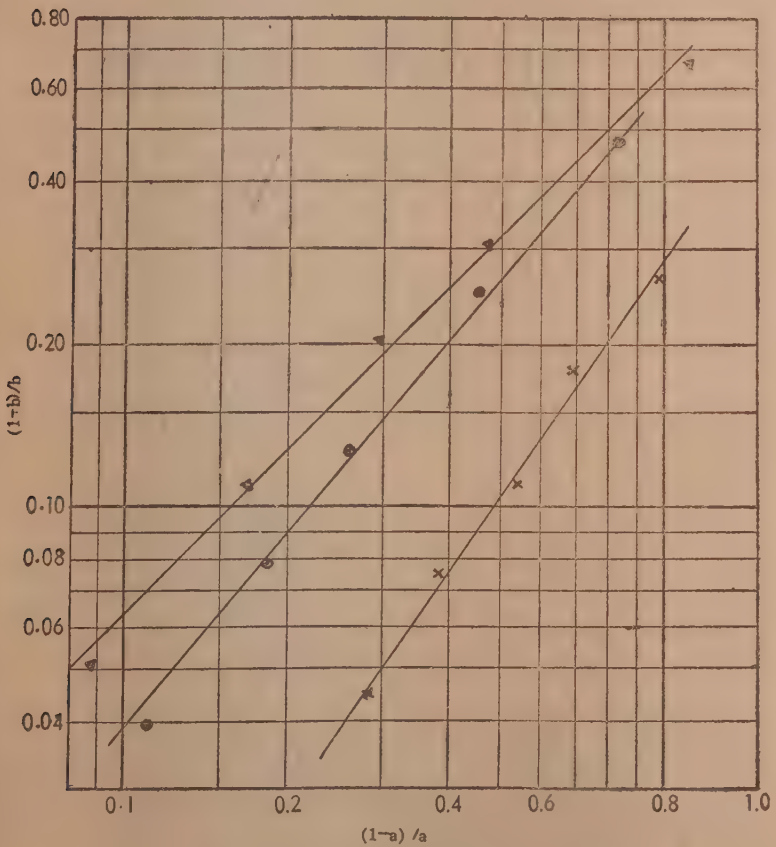

Fig. 5. Correlation of Tie line data.

(a—Weight fraction of oil in oil phase).

(b—Weight fraction of alcohol in alcohol phase).

× Alcohol 100% ⊙ Alcohol 95% ▼ Alcohol 90%

Effect of water on the ternary mutual solubility.

The conjugate phases in each of the experiments for the determination of tie line data were distilled to recover alcohol. The densities of the samples thus obtained were determined. It was found that the density of alcohol recovered from the equilibrium phases was substantially the same as that of the initial solvent used. The deviation in concentration thus determined was never more than 0·5%. This indicates that the 95% and 90% alcohol used in the ternary systems behaved as if each was a single component. The effect of addition of water to alcohol was, however, very pronounced in increasing the area of immiscibility. However, increased amount of water present in alcohol tends to increase the affinity of oleic acid to remain in oil phase as indicated in Fig. 4 for 90% alcohol. This observation has also been made by Rigamonti *et al* in the study of the system triolein—oleic acid—alcohol using 90%, 95% and 100% methyl alcohol (1951).

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Tectonics of the Granites and Gneisses of Tiruchengode

BY

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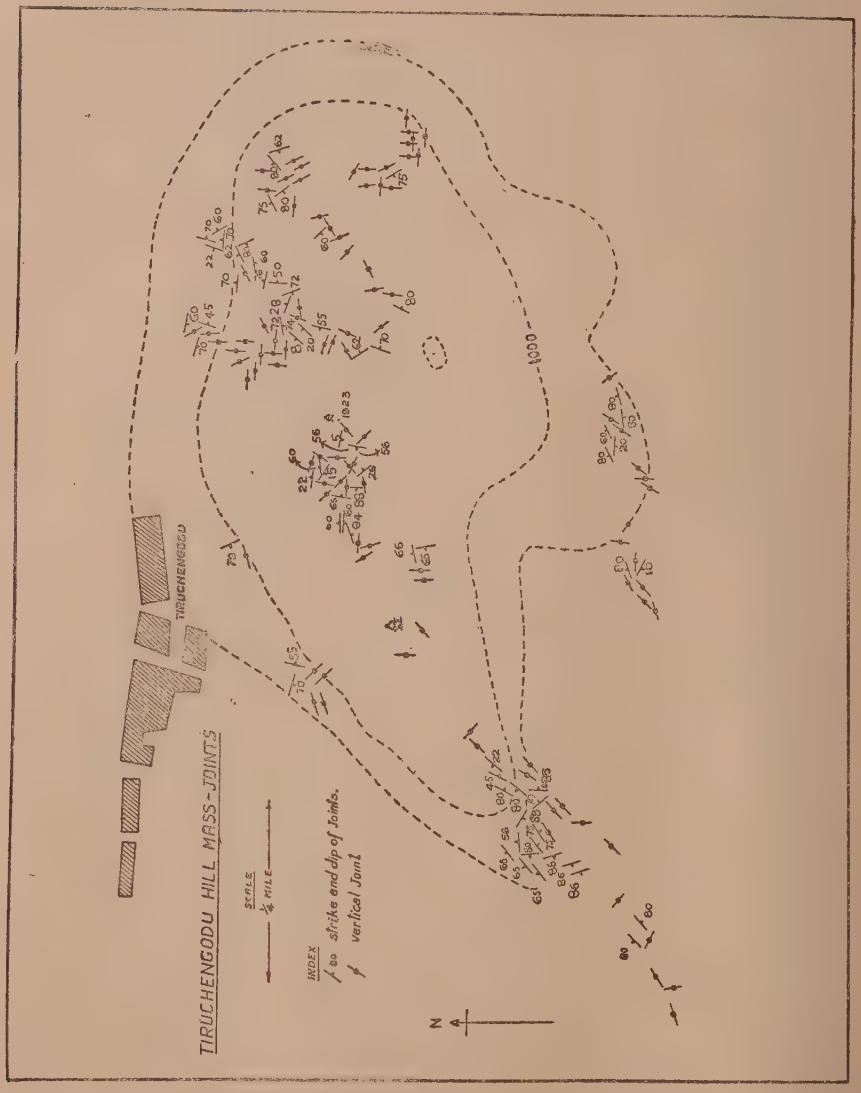
(Received for publication, August 24, 1955)

ABSTRACT

From a study of the poles of joints in stereographic projection it is concluded that the Tiruchengode granite intruded as a dome. The petrofabric diagram of the c axes of the quartzes of the granite and migmatite of this area correspond to Ia, and IVi of the schematic diagrams of quartz axes as given by Fairbairn (1954). The conclusion is reached that the granites and migmatites may have been once quartzites, which have been subjected to rheomorphism.

One hundred and fifty joints have been studied and their dips and strikes noted from the Tiruchengode hill mass consisting of the Tiruchengode granite. These have been plotted in an enlarged map (Map 1.) on a scale of 1 mile = 8 inches. The joints are also plotted in a stereographic net and the point diagram (Fig. 1) and contour diagram (Fig. 2) are prepared. The contour diagram shows maxima in the north, south, east and west poles. This shows that the granite mass has intruded and come up like a dome (Billings, 1946). The other minor maxima are distributed around the periphery indicating shear joints along which the mass has sheared, and the various pegmatites and quartz veins have intruded along the shear plane. The conclusion that the granite has intruded as a dome is in accordance with the author's view (1955) given after a study of a combined map of Tiruchengode and Sankaridrug area published earlier (J. Madras Univ. B., 1955) — (Ref. Map. No. 2 of that article).

Two rocks have been taken and studied for petrofabrics. A section is cut perpendicular to the visible plane of foliation (therefore perpendicular to 'b' axis of Sander) and the thin section is worked for the orientation of quartz grains.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MAP 1

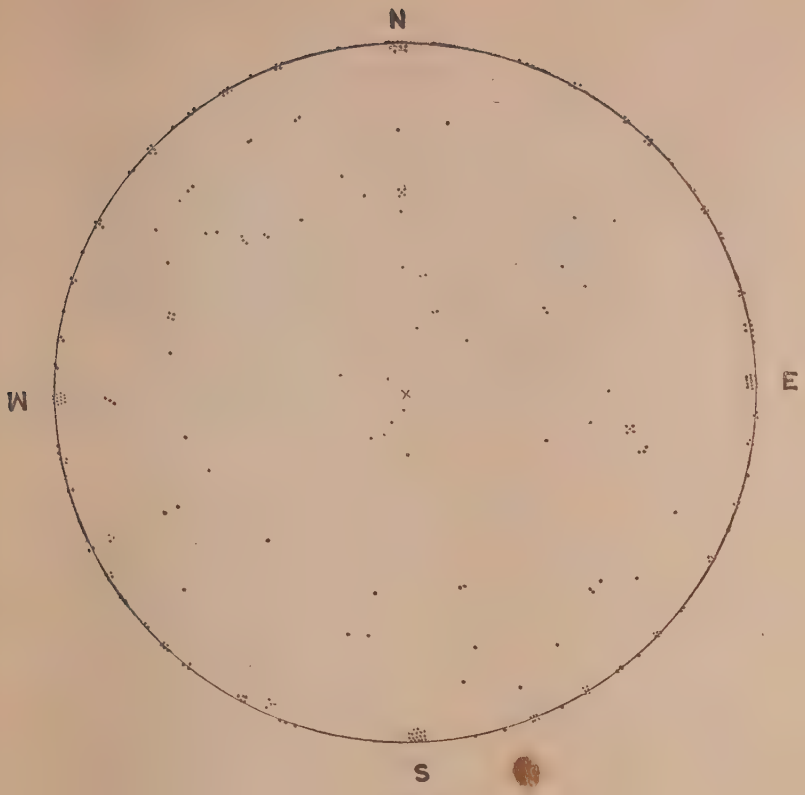
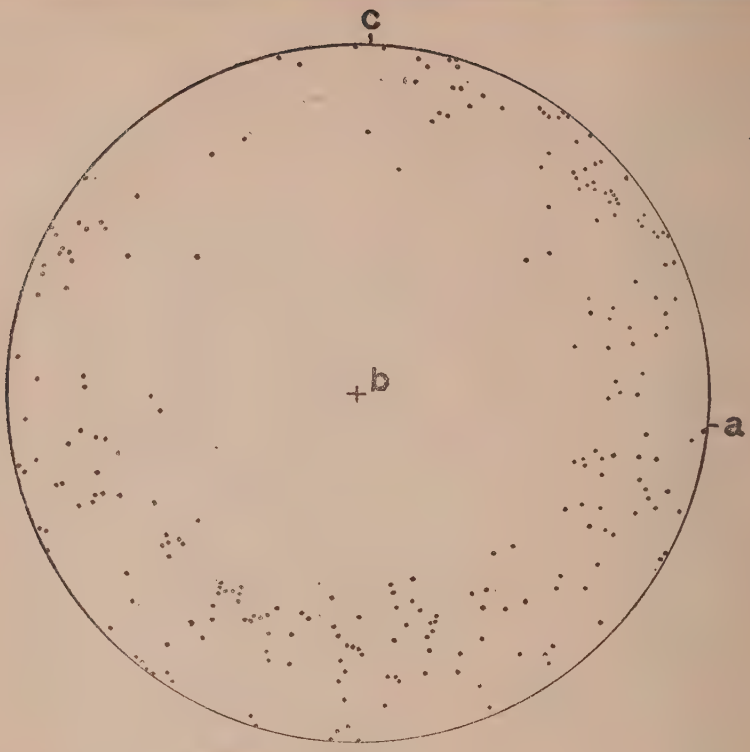


Fig. 1.

Fig. 2.



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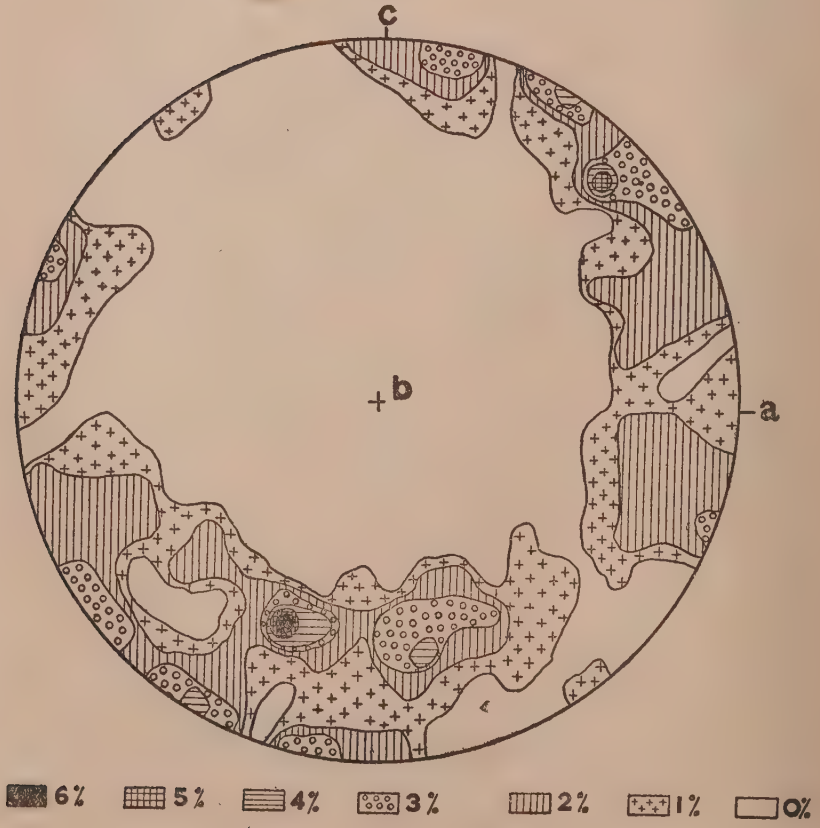

Fig. 4.

From a garnetiferous mixed gneiss collected from Ilamballi (a village on the banks of river Cauveri about 16 miles south west of Tiruchengode), the orientation of 250 quartz grains are plotted in a schmidt net and the point diagram, southern hemisphere (Fig. 3) and contour diagram (Fig. 4) are prepared. This contour diagram shows a double maxima nearly north-west and south-east and there are other minor maxima around the periphery. This diagram corresponds with the Ia of the schematic

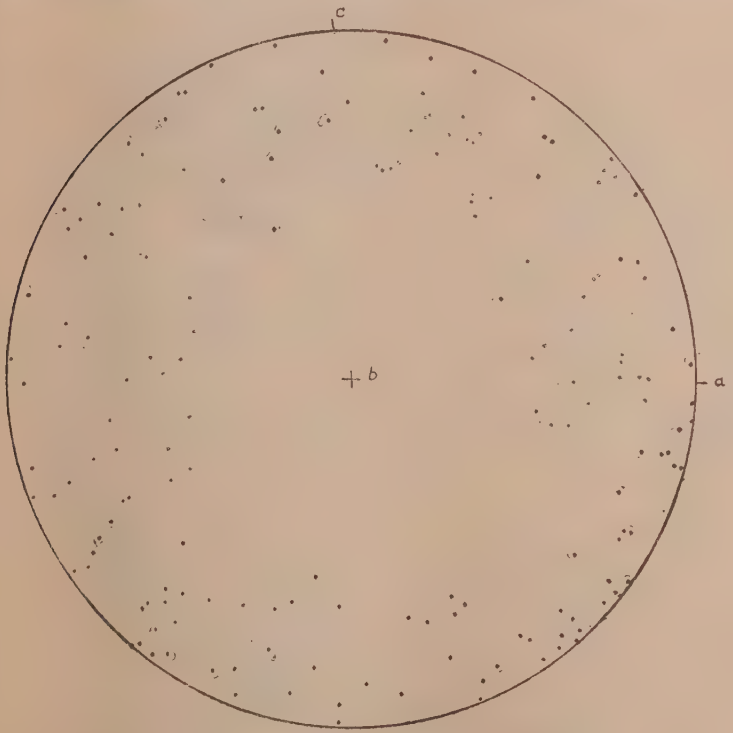

Fig. 5.

diagram showing the types of quartz axes of Fairbairn, (1954) (p. 10).

The other rock chosen for study is a migmatite of the Biotite gneiss and the Tiruchengode granite (collected from near the village Kunnamalai near Sittampundi). The orientation of 200 quartz grains have been plotted in a schmidt net from this rock. The

point diagram (Fig. 5) and the contour diagram (Fig. 6) are also drawn.

This contour diagram shows roughly four maxima nearly in the NE, SW, NW and the SE quadrants with a girdle around the periphery. This corresponds with IVi of the schematic diagram of quartz axes given by Fairbairn (*op. cit.*).

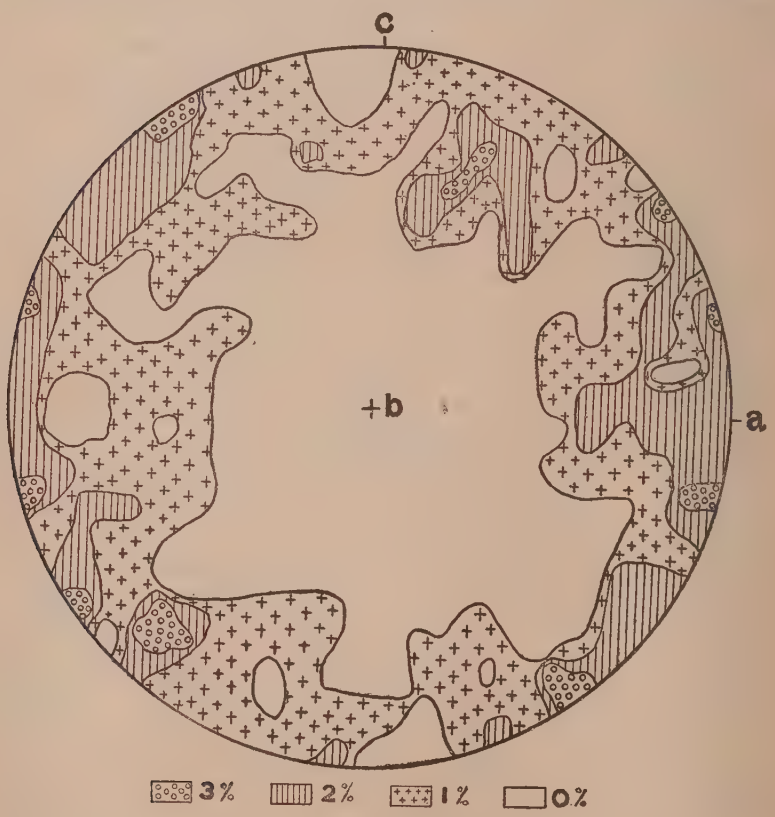

Fig. 6.

Similar diagrams have been given by Fairbairn, Sander and Turner and Verhoogan for quartzites. The two diagrams can be compared with quartz diagrams 6 and 17 respectively of Sander 1950 (p. 356 and 358).

Thus these observations lead us to the conclusion that the Tiruchengode granite may have been once quartzites. It can be

compared in this respect to the Grenville series where according to Buddington quartzites have been converted to granite and pegmatites by rheomorphism.

ACKNOWLEDGMENT

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Food and Feeding Habits of Juveniles and Adults of Four Fishes of Madras

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ABSTRACT

An examination of the stomach contents of 235 specimens of *Upeneus indicus*, 178 specimens of *Polydactylus indicus*, 175 specimens of *Polynemus sextarius* and 121 specimens of *Leiognathus ruconius* showed that crustacea form the main food item of these fishes. Of these adults of *Upeneus indicus* frequent the sea bottom occasionally to feed on the mud rich in organic matter while the juveniles feed at the surface and never go to the sea bottom. *Polydactylus indicus* showed a selective preference for *Penaeus sp* and this specific partiality is evinced by the fish even in juvenile stages while *Polynemus sextarius* feeds voraciously on all prey whereas the juveniles of the same species is a promiscuous feeder. The adults of *Leiognathus ruconius* are vertically migratory in their feeding habits whereas the young ones are pure surface feeders confining themselves to items found in the plankton. These four fishes breed away from the Madras area and use the Madras inshore waters as feeding ground for adult and juvenile stages.

Introduction

The study of the food and feeding habits of Indian fishes, so essential for the development of Indian fisheries, may be said to have commenced with Job's monograph on the food of Indian Perches (1940). To this valuable contribution Vijayaraghavan (1950 unpublished thesis) has added the information about the diet of 17 species. Mention must also be made of the numerous notes and short papers on the diet of the Indian fishes by Day (1873, 1889), Hornell and Nayudu (1923), Devanesan (1932, 1942 and 1943), Hora and Nair (1938), Malik (1940), Chidambaram (1944), Chidambaram and Kuriyan (1952), Chidambaram and Devanesan (1953), Duttar (1954), Jacob and Krishnamurthy

(1948), Chacko (1945, 1949a, 1949b), Bapat and Bal (1950), Pillay (1951a, 1951b and 1952), John and Menon (1942), Gopinath (1942 and 1946), Malhotra (1953), Mohammed (1955), Khan (1934), Menon (1948), Mukerji (1946), Venkataraman (1944) and Alikunhi (1952). In the present paper the food and feeding habits of 4 fishes occurring in Madras waters are dealt with, both adults and juveniles having been studied. The adults and juveniles of species visit the Madras inshore waters for feeding purposes only and migrate elsewhere for spawning and early development. Since the juveniles of *Leiognathus* and *Upeneus* are netted and marketted and since the adults of *Polynemus* are also landed in considerable numbers, their sojourn in Madras waters and their migration elsewhere are of interest in long range fishery programmes.

Material and Methods: A total number of 851 fishes were examined of which 626 were adults and 225 were juveniles. The usual method of treating the volume of water displaced as that of the stomach contents was followed with reference to the volume measurement of the stomach contents of the adult fishes whereas regarding the juveniles the following method was adopted. As soon as the juveniles were brought to the laboratory they were measured and their stomach contents were teased out on to a slide with the help of a fine needle. The stomach contents were squeezed out and washed with a measured quantity of water and transferred to a watch-glass and were examined qualitatively for the identifiable food ingredients of the stomach. After the microscopical analysis of the gut contents, a quantitative estimate of the stomach contents was made as follows. A glass-tube with an internal diameter of 2·5 mm. was taken and marked out at distances of 4 mm. when the volume of water held between two such divisions would equal to 0·01 cc. A rubber teat was attached at the end of such a tube and the food items taken in the watch-glass were measured volumetrically to the nearest second decimal place. For the estimation of quantities of the various items of food Pearse's method (1915) was adopted. The four fishes dealt with in the present paper are:

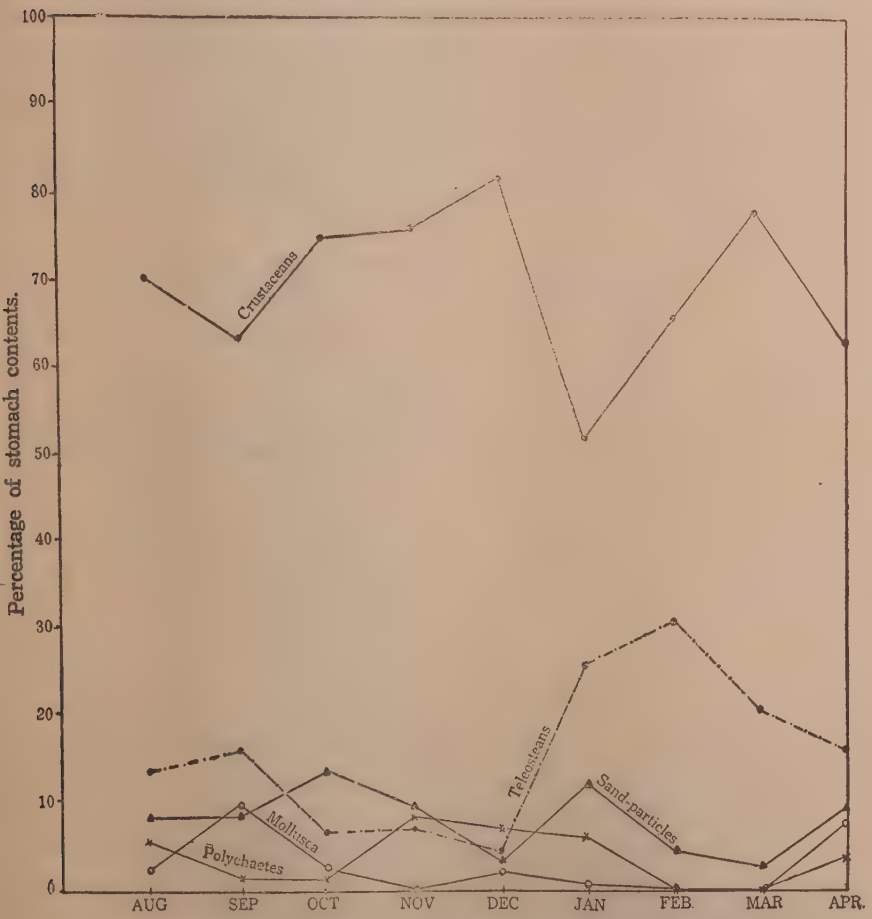
I. Family: Mullidae
Genus: *Upeneus*
Species: 1. *Upeneus indicus* (Shaw)

II. Family: *Polynemidae*
Genus: *Polydactylus*

Species : 2. *Polydactylus indicus* (Shaw)
Genus: *Polynemus*
Species : 3. *Polynemus sextarius* (Block)

III. Family. Leiognathidae
Genus: *Leiognathus*
Species : 4. *Leiognathus ruconius.* (Cuv. & Val)

Upeneus indicus : (Shaw) :—This Goat-Fish or Red mullet is popularly called by fishermen "Kul-Navarai" and is one of the



GRAPH I. Monthly variations in the proportions of the food contents of *Upeneus Indicus* (Shaw).

esteemed food fishes of Madras. The fishermen locate the shoals of Goat-Fishes by the sight of silver-bellies leaping in the air. The fish is landed in large numbers in December but occurs in the nets in moderate numbers all the months. It is noteworthy that juveniles of this form occured in March and April. It is probable that the fish breeds in January and uses the inshore area as a feeding ground and as a nursery.

235 specimens of the above species were examined in the Laboratory from the month of August 1953 to March 1955. All the fishes had food in the stomach except sixteen. The fishes ranged between 8 cm. to 18 cm. in length out of which 14 were 8 cm. long and 12 were 18 cm. long and the rest were intermediate between the two. In spite of the differences in size the diet did not vary. Out of 70 males, 41 were mature and out of 165 females 67 were mature. From the examination of these mature and immature fishes the values for which are given in table below shows that the latter appear to take relatively more food than the former.

Table showing the condition of feed and also the length of the fishes examined during mature and immature stages:

Condition of fish	Length of fish					
	8 cm. to 11 cm.		12 cm. to 15 cm.		16 cm. to 18 cm.	
	mature	immature	mature	immature	mature	immature
Empty ..	3	—	4	2	6	1
Little ..	4	1	5	2	2	1
1/4 ..	5	4	8	7	9	6
1/2 ..	3	12	2	18	5	—
3/4 ..	4	21	4	12	9	10
Full ..	10	20	8	7	8	12

However the present author admits that such a conclusion can only be accepted with due caution especially in view of the fact that these data were based on a study of just 235 individuals collected at Madras from fishermen's hands; irrespective of the possible difference in the time of capture, ecological condition of the catch and other bionomic factors. The total volume of the food consumed by each fish was measured and averaged for the month.

The stomach contents were analysed into different constituents and the data obtained are tabulated as follows:—

Table showing the average total volume of food and also the percentage average of the various food items of Upeneus indicus:

Particulars.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
No. of fishes examined	21	33	26	22	58	34	11	16	14
Volume of stomach contents in cc.	0·7	0·7	0·5	0·7	0·6	0·7	1·0	0·7	0·5
Crustaceans	70·1	63·3	74·9	75·0	81·6	52·0	65·3	77·4	62·7
Teleosteans	13·3	15·9	6·7	7·2	4·7	25·6	30·4	20·2	16·0
Molluscans	2·3	9·9	2·5	—	1·8	0·7	—	—	8·0
Sand particles	8·4	8·9	13·8	9·2	4·3	12·0	4·3	2·4	9·4
Other items	—	0·4	—	0·4	0·6	3·3	—	—	—
Polychaetes	5·9	1·6	2·1	8·2	7·0	6·4	—	—	3·9

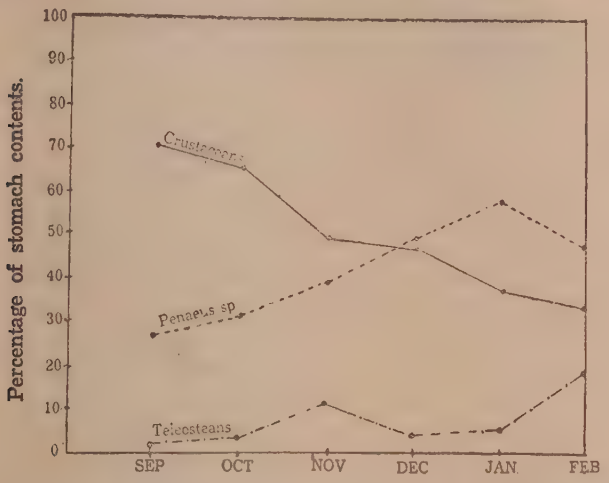
From the table, it is evident that crustacea form the main bulk of the food of *Upeneus indicus*. Of the crustacea, *Metapenaeus, monoceros, Penaeus carinatus, Penaeus indicus, Emerita sp, Acetes erythraeus, Squilla holoschista, Squilla mantis, Mysis* and *cumacea* are noteworthy. Zoea and Megalopa stages of crab as well as remains of other crustacea formed a smaller fraction. Juveniles of *Clupeidae* and *Engraulidae* formed the principal teleostean food item while juveniles of *Polynemidae* and *Leiognathidae* were also present in the stomach. Fish eggs were found in very small quantity, probably taken in accidentally. 65% of the volume of the stomach contents of a single species of length 13·0 cm. caught on 27th February 1954 was of *Stolephorous*. Two fishes examined on 12th January 1954 had fed indiscriminately on large quanties of teleostei and their stomachs were clogged with fish. Since this fish feeds on post larval fish and juveniles of species of market value it may be concluded that this Madras Red Mullet is harmful to fisheries. Larval bivalves, gastropods and broken bits of shells indicated that Mollusca form a minor item of diet which reaches the maximum level in the month of September. Except in February and March, parapodia isolated segments and setae of poly-

chaetes were present. They were found in such an advanced stage of digestion that specific identification was not possible. Traces of green digested matter were also found. From the fact of sand being found in appreciable quantities and from the fact that sand was found in the stomach even during the months of February and March when there were no remains of polychaetes, it may be concluded that this Red mullet feeds on mud. It is probable that like other members of the family, *Upeneus indicus* subsists on the organic matter present in the bottom sand. This fact is further confirmed by the presence of the tubes of the tube-dwelling polychaetes and also Molluscan food. All the above facts suggest that this Goat-Fish is a bottom feeder.

Apart from the adult specimens, 43 juveniles of *Upeneus indicus* were collected and examined in the laboratory. Except four, all the rest had food in the stomach. These juveniles ranging from 2 cm. to 6 cm. in length, occur in the month of March and April. Since an examination of the inshore plankton of Madras has yielded no eggs of *Upeneus indicus,* it may be suggested that these juveniles have migrated from spawning area elsewhere to Madras waters for feeding purposes. Since the adults also feed in the same area from August to April, it is evident that Madras water is the feeding ground of both juveniles and adults. It is also evident from the data obtained that while both juveniles and adults feed on crustacean food, the adults prefer the larger crustacea, while the juveniles take in smaller forms such as *Mysis,* zoea larva, cumacea, young ones of *Acetes,* Veliger larva, larval bivalves, larval gastropods and pteropods. Teleostean food item was very negligible. Teleostei were represented by fish eggs and post larval forms. From the above diet, it is clear that these juveniles may be surface feeders whereas the adults are vertically migratory in their feeding habits. But there is no indication of change of diet during its growth from the juvenile stage to the adult at least in those periods the fish spends in Madras inshore area.

From the graph (No. 1) it is clear that crustacea form the main bulk of food reaching a peak in the month of December. The sudden fall in crustacean diet in the month of January is compensated by the increase of Teleostei, sand particles and polychaetes. Regarding the volume of food, the fish feeds most in February and least in the months of October and April, whereas in the months of August, September, November, January and March the feeding is uniform.

II. *Polydactylus indicus*: (Shaw) This fish belongs to the family polynemidae of the order Acanthopterygii and is one of the valued food fishes of Madras and is generally called Indian Salmon or the Row-ball. It is known as "Kala" in Tamil. The maximum



GRAPH II. Monthly variations in the proportions of the food components of *Polydactylus indicus* (Shaw).

length attained by this fish commonly captured in the mouths of large rivers, is about 4 feet (Devanesan and Chidambaram 1953). The stomach contents of both juveniles as well as the adults obtained from the fishermen's nets at Madras were analysed.

178 adults were examined from September 1953 to February 1955. Except 8, all had food in the stomach. After February not even a single specimen was landed at Madras. The obvious inference is that these fishes migrate away from Madras waters and return to Madras inshore waters only in the month of September. Though they occur in moderate numbers from September to February a maximum number of species was obtained in December. Of the 178 fishes examined, 7 were 8·5 cm. and 8 were 26·5 cm. in length and the rest were intermediate between the two. The shortest, the longest as well as the fishes of intermediate size groups exhibited more or less the same mode of feeding. But the juveniles of these species examined showed vast difference in their feeding habits. There were 49 males of which 12 were mature and 129 females of which 9 were mature and the rest were im-

mature. There was no difference between the mature and immature fishes as regards their feeding. It is evident from the data collected that the maturity stages do not in any way affect the feeding habits of these fishes as it does in certain other species.

The volumes of stomach contents were measured. The undigested and identifiable constituents were separated and expressed in percentages of the total volume of food (see table):

Table showing the average total volume of food and also the various food items of Polydactylus indicus:

Particulars	Sep.	Oct	Nov.	Dec.	Jan.	Feb.
Total number of fishes examined ..	24	18	27	47	31	31
Total volume of stomach contents in cc. ..	1·8	0·8	0·8	2·3	1·6	2·0
Penaeus sp. ..	27·1	31·7	39·8	49·5	57·6	46·6
Other crustecean items	71·2	65·2	48·3	46·5	37·5	33·4
Teleostean items ..	1·7	3·1	11·9	4·0	4·9	19·0

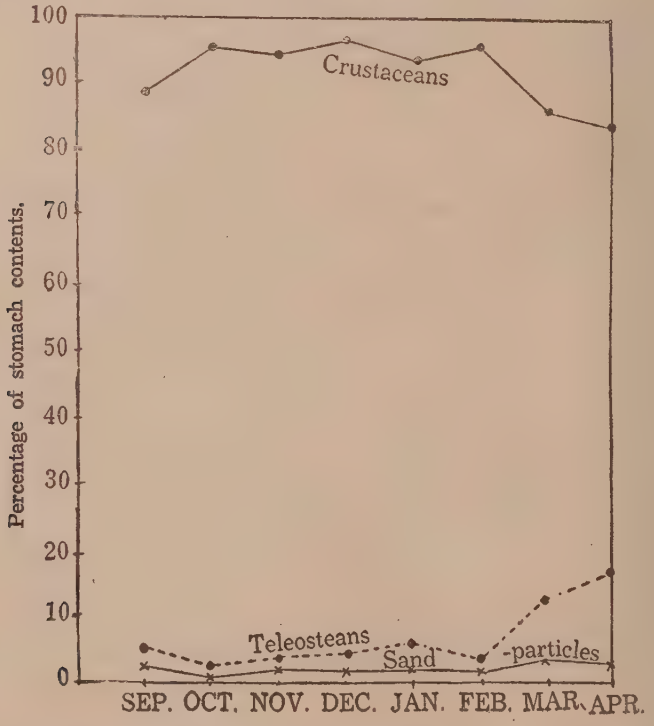
From the table, it is evident that crustacea form the main bulk of the food. The crustcean food appears to consist of chiefly the larger forms like *Penaeus indicus, Panaeus carinatus, Charybidis annulata, Neptunus pelagicus, Albunia, Hippa sp, Squilla sp,* and *Acetes sp.* There were also unidentifiable appendages and other remains of crustacea. The fact that all these crustaceans are fast swimming suggests that the fish is a predator which can chase and capture its prey. Most of the stomachs of *Polydactylus indicus* were filled with adult *Penaeus carinatus* as well as the young ones. A single fish of length 25 cm. caught on 18th September 1953 had 20 adults of *Penaeus carinatus* in the stomach which measured 9 cc. The preponderance of *Penaeus carinatus* in the stomach suggests that this fish has a partiality for this crustacean though other crustaceans occurred in the area. *Teleostean* food is relatively very small and these were represented by fish eggs, scales, vertebral column, pectoral girdle and parts of skeletal system. In the stomach of one specimen a complete alimentary canal of another teleost was found. The possibility is of its having bitten off the entrails of another fish or fed on the

remains of a fish mangled by others. A single juvenile of *Citharichthys sp* was identified in the stomach of another fish. This, however, will not indicate its frequenting the bottom for feeding, but that the prey which is a bottom feeder should have wandered into higher levels. *Leiognathus sp* was also found in the stomach. Traces of Polychaetes were seen in the stomach only in January. They were in a state of advanced digestion and no specific identification was possible. It is probable that these Polychaetes formed the stomach contents of the fish prey and may therefore be considered secondary items. Sand particles were seen in the stomach in negligible amount. These also can be considered secondary taken along with the fish larva and crustaceans. *Polydactylus indicus* is purely carnivorous in its feeding habits. A total number of 58 juveniles of *Polydactylus indicus* ranging from 2 cm. to 6 cm. in length were examined in the month of April, September, January and February and their stomach contents were analysed. Except 3, all had food in the stomach. It is evident from the analysis that the juveniles feed on smaller crustaceans such as copepods (*Oithona sp, Calanoid sp, Euterpina sp*) post larval forms of *Penaeus carinatus* and *Penaeus indicus, Acetes sp Lucifer,* zoea, megalopa stages, and there were also unidentifiable crustacean appendages. Sagitta were also found in the stomach. Post larval fish belonging to the family *Engraulidae* were identified. The selective feeding or partiality for *Penaeus sp* exhibited by the adult fish is revealed even in the juvenile stages of this fish, the young fish feeding more on the smaller size groups of Prawn. This shows clearly that even from the early period the fish has a peculiar way of selecting its food. As no eggs of *Polydactylus indicus* are found in the inshore plankton and whereas the adults and juveniles are netted, we may infer that this fish also uses the Madras area as the feeding ground during the young and older stages while it migrates to other areas for spawning. The adult species are midway feeders whereas the juveniles are surface feeders.

It is clear from the graph (No. 2) that the rise in the Prawn food item is accompanied by a fall in the general crustacean food item during September to January period. A fall in the *Penaeus* food item from January to February period is accompanied by a corresponding rise in teleostean food item. A fall in *Penaeus* food item from January to February is not accompanied by a rise in general crustacean food item; on the other hand it too showed a fall. While *Polydactylus indicus* selects *Penaeus sp,* its predominent food

item, the absence of this latter form necessitates this fish to subsist on other fish rather than on other crustacea as is apparent from the graph from the month of January to February. When we compare the total volume of stomach contents a steady rate of feeding is noticed in the months of October and November whereas it reached its peak in the month of December.

III. *Polynemus sextarius* (Block): This Indian Salmon differs but slightly from the former species and is also called "Kala". The first dorsal fin is black spotted, pectoral and ventral



GRAPH III. Monthly variations in the proportions of the food components of *Polynemus sextarius* (Bl. Schn.)

fins have numerous black spots, other fins more or less dotted with black and often black edged (Day 1889). Distributed in East Coast of Africa, seas of India, to the Malay Archipelago. Both juveniles and adults were collected and their stomach contents were analysed.

A total number of 175 adult specimens were examined from September 1953 to March 1955. Except 10 all had food in their stomach. The specimens, examined ranged from 7 cm. to 21 cm. in length. 4 were 7 cm. and 6 were 21 cm., the rest being intermediate between the two. There is no difference in the feeding habits of adults with regard to size groups. Out of 52 males 10 were mature and out of 123 females 12 were mature and the rest were found immature. There was no difference between mature and the immature fishes with regard to feeding.

The volume of food in the stomach was measured and the food was analysed into different constituents, the data obtained were tabulated after obtaining the monthly averages for the different samples examined throughout the year.

Table showing the average volume of food and also the percentage average of the various food items of Polynemus sextarius:

Particulars.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
No. of fishes examined ..	28	17	23	36	17	29	12	13
Volume of stomach contents in c.c. ..	0·3	0·4	0·6	0·7	0·7	0·8	0·7	0·5
Crustaceans ..	89·0	95·8	94·8	95·4	92·5	95·0	85·8	83·2
Teleosteans ..	4·7	1·8	2·6	3·5	5·8	3·2	10·7	14·2
Sand particles ..	2·5	1·1	2·6	1·1	1·7	1·0	3·5	2·6
Molluscans ..	3·8	1·3	—	—	—	0·8	—	—

From the table, it is evident that crustacea form main bulk of the food of which *Acetes sp, Squilla mantis, Cumacea, Penaeus carinatus, Penaeus indicus, Acetes sitiferous,* megalopa stage of crab, *Neptunus pelagicus* and *Charybidis sp* being the most notable. Apart from this there were also unidentifiable crustacean appendages and other crustacean remains. A fish 8 cm. long examined on 19th October, 1953, had swallowed a *Squilla sp* 6 cm. long. It was found that the Squilla pierced through the alimentary canal into the body cavity. Such instances suggest the degree of voracity of the species. *Teleostei* form relatively a small proportion of the total food since it ranges from 1 to 3·5% only. They were mainly juveniles, fish eggs, scales and vertebral column and such

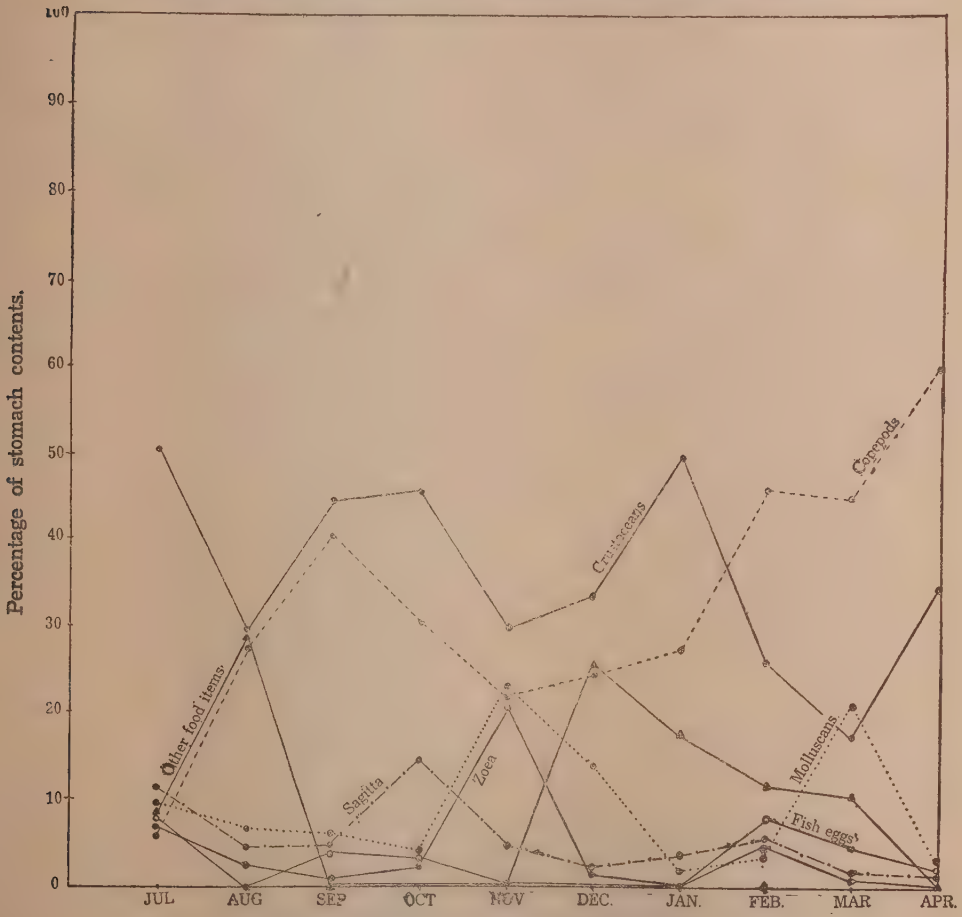
remains of other fishes were also found. Fish belonging to the genus *Engraulis* and *Clupea* were the most frequent teleostea on which the fish feeds. The presence of polychaetes, Molluscan and other remains are only secondary since these forms might have been derived from the stomachs of crustaceans and teleostei that the fish had consumed.

The analysis of the stomach contents of 175 fishes showed that sand particles formed an average of 2·5% of the total volume of food. The presence of the sand particles in the stomach of the fish may be only accidental or because it forms a part of the regular diet. From the data of other food items, it is evident that *Polynemus sextarius* is not a fish which frequents the benthic region and hence there is no possibility of this fish taking sand particles as part of its regular diet. On the other hand, since the fish feeds in inshore waters subject to incessant wave action, there is a possibility of shore sand being mixed up with water to some extent. So sand particles may be swallowed along with the prey. It is not likely that the sand came from the guts of the teleostean or crustacean victims since *Clupea* and *Engraulis* juveniles on which the fish feeds are also surface feeders. The crustacea as a rule do not have much of sand. The polychaetes which form only very small percentage of the food also appear to be pelagic.

Juveniles: A total number of 41 juveniles of *Polynemus sextarius* ranging from 2 cm. to 6 cm. in length was collected in the months of July, September, February and April. Except 3, all had food in the stomach. The juveniles feed on small crustaceans such as copepods, *Cancer* larvae, *Acetes*, megalopa, zoea and *Mysis* stages of crab, polychaetes and other small unidentifiable crustacean appendages. Sagitta, and Molluscan larvae were very rarerly met with in the stomach. It will be seen that while the adults feed on crustaceans and fishes which they capture by chasing, the juveniles being smaller in size feed on smaller crustacea and also the larval forms of larger crustacea. Though the juveniles are surface feeders, we cannot regard them as plankton feeders since the features of structure, characteristic of plankton feeders are not in evidence. Since both juveniles and adults feed in the same area, it is probable that the Madras inshore area is the feeding ground for both juveniles as well as the adults. It is also probable that since no eggs of *Polynemus sextarius* are found in the Madras inshore plankton, these fishes most probably migrate away from Madras waters for spawning purposes.

When we compare the total volume of food, we find that the fish feeds most from December to February and least in September. The fall in the crustacean food item in the month of April is compensated by teleostean food item.

IV. *Leiognathus ruconius* (Cuv and Val): This carangid is one of the common food fishes of the Madras coast but is distri-



GRAPH IV. Monthly variations in the proportions of the food components of *Leiognathus ruconius* (Ham. Buch).

buted in seas of India to Malay Archipelago and beyond. The tamil name for this species is "Oolakaral". Nothing is known about the food and feeding habits of this fish. Both adults as

Table showing the average total volume of food and also the percentage average of the various food items of juveniles of Leiognathus ruconius:

Particulars		July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
No. of fishes examined	..	5	8	11	10	5	6	5	10	10	5
Volume of stomach contents in c.c.	..	·07	·04	·04	·04	·05	·05	·06	·07	·06	·05
Copepods	..	50·6	29·2	44·8	45·2	30·0	33·6	49·6	25·0	17·1	34·6
Appendages & other crustacean remains	..	5·6	27·9	40·7	30·4	21·9	24·1	27·4	46·0	45·0	60·0
Sagitta	..	11·2	4·4	5·0	14·4	4·3	2·2	3·8	5·7	1·9	1·1
Molluscans	..	9·7	7·0	5·2	4·0	22·9	13·4	1·9	—	20·9	2·7
Zoea	..	6·7	2·3	0·8	2·4	20·9	1·1	—	3·4	0·8	—
Fish eggs	..	7·7	—	3·5	3·6	—	—	—	11·9	4·3	1·6
Other items	..	8·5	29·2	—	—	—	25·6	17·3	8·0	10·0	—

well as the juveniles were examined though as a rule the adults 'are fewer while the juveniles are the ones most marketted. Only 38 adults were found during the course of investigation and all the specimens examined were collected from the fishermen's net.

A total number of 83 juveniles of the above species was examined in the laboratory from September 1953 to March 1955. Except 7, all the others had food in the stomach. The juveniles examined ranged between 1 cm. upto 3·5 cm. in length out of which 7 were 1 cm., 5 were 3·5 cm., in length and the rest being intermediate between the two. Though the juveniles were found from September to April the maximum number of fishes was examined in the month of September.

The volume of food and the percentage average of the different food items are presented in the table on page 248.

From the table it will be obvious that crustacea form the main bulk of the food of which copepod, and zoea forming the chief item. Apart from this there were small crustacean appendages and also other unidentifiable remains of crustacea. Copepods were represented by *Oithona sp, Acartia sp, Oithona rigida, Paracalanus parvus,* and *Euterpina acutifrons.* Of the chaetognatha Sagitta was identified. Molluscan food items were present in almost all the months except in the month of February. They were usually larval gastropods, bivalves, veliger larva and Pteropods. About 5% of the total volume of food were fish eggs. Apart from these there were present very small quantity of *Lucifer,* Diatoms and Algae, Polychaetes, Echinoderm besides other unidentifiable matter. The sand particles formed a very negligible amount and it is probable that they were accidentally taken along with the food.

Of the 39 adults examined, all except 3 had food in the stomach. There were 23 males of which 10 were mature and out of 18 females 12 were mature and the rest were immature. The examination of the stomach contents revealed the presence of sand particles, foraminifera and polychaetes. Of the foraminifera, *Rotalia* and *Biloculina* were identified. The presence of these items in the stomach suggests the benthic feeding of the fish, whereas the presence of *Acetes, Squilla* and *Penaeus sp* suggests that they feed in the upper layers of water while the presence of copepods, Sagitta, zoea and other larval forms suggests the surface feeding of the fish. So it is clear from the data collected that adult *Leiognathus ruconius* is vertically migratory in their

feeding habits whereas the young ones are pure surface feeders confining themselves to items found in the plankton.

From the graph No. 4 setting forth the analysis of the stomach contents, it can be clearly seen that crustacea form the main bulk reaching a peak in the month of April. The maximum fall of copepod food item is noticed in the month of March which is compensated by the Molluscan food item. In the month of November, the fall is compensated by Molluscan food as well as zoea whereas in the month of February the copepod food item is compensated by fish eggs and fish remains. When we compare the date of the total volume of stomach contents during these months, we find that the fish feeds most in the months of July and February and least in the months of August, September and October. During these months the feeding is more or less steady.

Summary

1. The stomach contents of four fishes *Upeneus indicus, Polydactylus indicus, Polynemus, sextarius,* and *Leiognathus ruconius* of market value have been analysed and their feeding habits studied. All the four are carnivorous feeders.

2. *Upeneus indicus* appears to feed at all levels. It not only feeds at the surface but also frequents the sea bottom to feed on the mud rich in organic matter. The juveniles of this species feed at the surface only and do not descend to the bottom. They are however carnivorous like the adults.

3. *Polydactylus indicus* shows a selective preference for crustacea and for *Penaeus spp,* in particular, while *Polynemus sextarius* feeds voraciously on all prey. Both these fishes appear to feed in the mid water levels. Even in the juvenile stages, *Polydactylus indicus* shows a selective feeding prefering young prawns and *Acetes sp* while the juveniles of *Polynemus sextarius* are promiscuous feeders.

4. *Leiognathus ruconius* feeds on both Planktonic as well as bottom forms whereas the juveniles of this Silver belly feed only on zooplankton.

5. The adults of these 4 species leave Madras waters when the food becomes scarce for feeding and spawning purposes as well. The eggs and larvae of none of these forms have been met with in townet plankton. The juveniles of *Leiognathus ruconius* are met with almost throughout the year whereas the adults are netted

from October to February and migrate elsewhere for feeding and spawning. *Upeneus indicus* on the other hand occurs throughout the year. The juveniles occur in Madras waters in March, April and August. So it is probable that they arrive from the breeding and nursery grounds of the species and in May they leave for other feeding grounds. The adults of *Polydactylus indicus* arrive in September and leave in February when the food becomes scarce and their juveniles arrive in March and April from elsewhere. It is probable that for this fish also, the breeding and nursery grounds are elsewhere. *Polynemus sextarius* arrives in September and leaves only in April and the juveniles are observed in March and April.

ACKNOWLEDGEMENT

I wish to thank Dr. C. P. Gnanamuthu, Director University Zoology Research Laboratory, Madras, for suggesting the subject and constant encouragement and guidance during the course of the work which was done in the Zoology Laboratory of the Madras University. My thanks are also due to Dr. T. J. Job for having gone through the paper and made useful suggestions.

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Tectonics of the Granites, Gneisses and Migmatites of Sankaridrug

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ABSTRACT

The structural study of the Sankaridrug massif, based on the field-technique originated by Hans Cloos has been done. The micro-fabric of the country rock and a migmatite is also reported.

A study of the joint planes together with the fabric of the Sankaridrug hill was done on the lines of study initiated by Hans Cloos. Map 1 is the record of joints as observed in the field. It is to be seen that lineation, which is mainly the direction of the arrangement of the mafic inclusions, trends N-S while the foliation of xenoliths is E-W. There are also a few horizontal joints.

The technique as applied to the granite involved 380 individual compass-clinometer readings of which 316 observations have been plotted. All the poles of joints were plotted on the upper hemisphere of Schmidt net and the contour diagram prepared from it. Fig. 1 represents a combined scatter and contour diagram of these joints. It is seen that there is a single maximum, with other minor maxima along the circumference. The single maximum points out that the major joint planes are N.S. dipping steeply to west. The minor maxima dispersed along the periphery in E-W and N.E.-S.W. suggest,

(1) Joints perpendicular to the major joints, and

(2) Diagonal joints across the above two sets.

There are also some horizontal joints. This fact indicates that the joints have developed parallel to the lineation, and perpendicular to it. That there are shear joints in this area is well brought out by displaced aplite pegmatite veins along shear joints filled later by pegmatitic material.


INDEX
JOINT-PLANES:
Horizontal
2°-14°
15°-29°
30°-44°
45°-59
60°-70°
71°-79°
80°-88°
vertical
30 strike & dip of foliation.
Horizontal lineation.
(22)
70
58


SANKARIDRUG HILL - MAP OF JOINTS.
SCALE
1 ¾ ½ ¼ 0 FURLONGS
1
1.
1000
N
50
60
30
85
60
60
2343
80
(9)
(3)
30
50
60
50

They are indicative of the fact that the granites have radially dipping joints along E-W, N.S. and N.E.-S.W. and are in conformity with the structure of the area (dome). The single maximum points

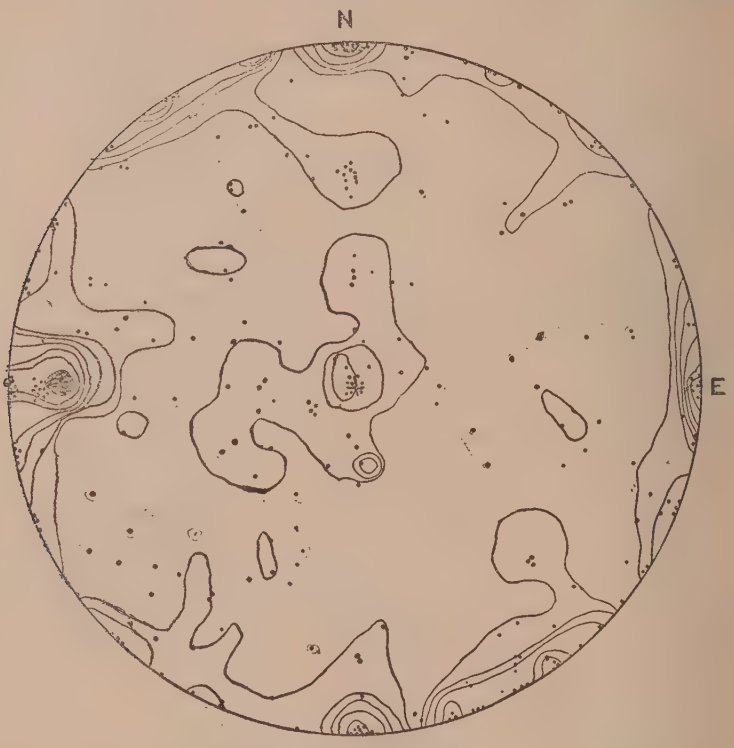

Fig. 1. Contour diagram of poles of Jt planes. 300 points Contour interval 1%. Maximum 8%.

out major shear joints in the mass which have been filled with great masses of pegmatite.

Petrofabric Study

The microfabric of a biotite gneiss and a migmatite was studied with sections cut perpendicular to 'b' axis. Quartz grains were studied for any preferred orientation. No selection of quartz grains was made. The plotting of poles of Quartz axes was after Sander (1948) who prefers to plot the pole of the plane of lateral axes of the quartz grains such that 'c' axes of quartz grains coincide with 'k' axis of the Federov stage. For this purpose an ellipsoidal

plane of quartz is located and checked whether it is the plane of the optic axis. If it is, then the plane is rotated through 90° and again a plane of the ellipsoid located. Now the stage is turned through 45° in the anti-clockwise direction and the grain tilted on 'k' axis. If it is the lateral axial plane it will be seen that the interference colour increases on either side by rotating on 'k' axis. Thus the optic axis of quartz is brought to coincide with the 'k' axis, and then plotted. The points were plotted in the lower hemisphere using a Schmidt net.

Two such diagrams prepared from the biotite gneiss and migmatite are given in Figs. 2 and 3. It is seen that the diagram of

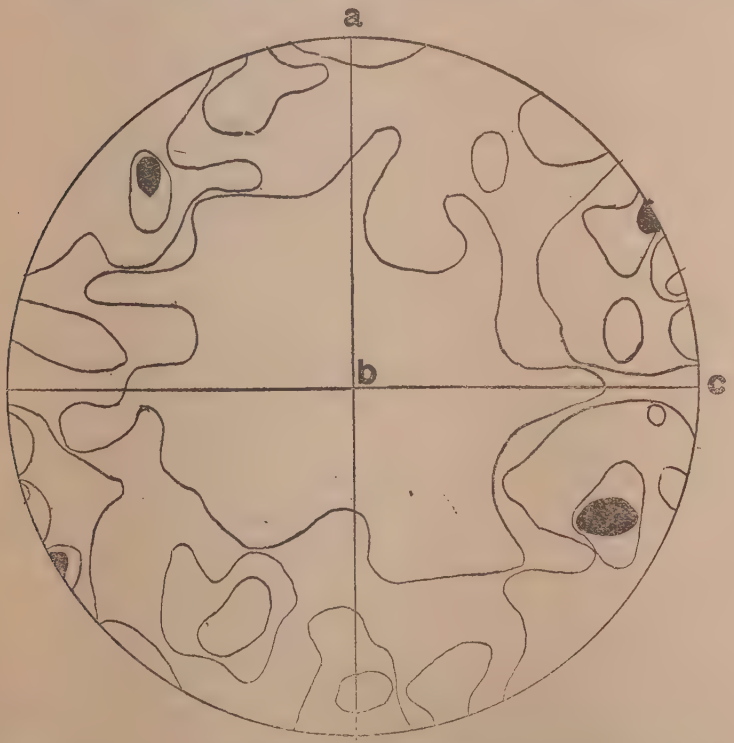

Fig. 2. Petrofabric diagram of Biotite gneiss. 300 quartz grains. Contour interval 1%. Maxima 4%.

biotite gneiss corresponds to the maxima I and V of Sander with four maxima placed diagonally at 90° from each other. There is also a girdle within which the maxima are situated. Such diagrams

have been described by Sander (1930), Schmidt (1925) and Phillips (1937) in schistose and quartz-rich rocks. This diagram has particular resemblance to diagram D_1 of Phillips (op. cit.) which is a diagram of a quartz-muscovite schist with some feldspar and epidote, with a characteristic lineation marked by the mica. Here we are dealing with a biotite gneiss which has got distinct foliation and is rich in quartz. The diagram (Fig. 2) shows a girdle with quartz axes orientated in the a-c plane of the fabric; there is typically a sector of strong concentration extending about 45° on either side of 'a' axis with prominent maxima near the sector boundaries.

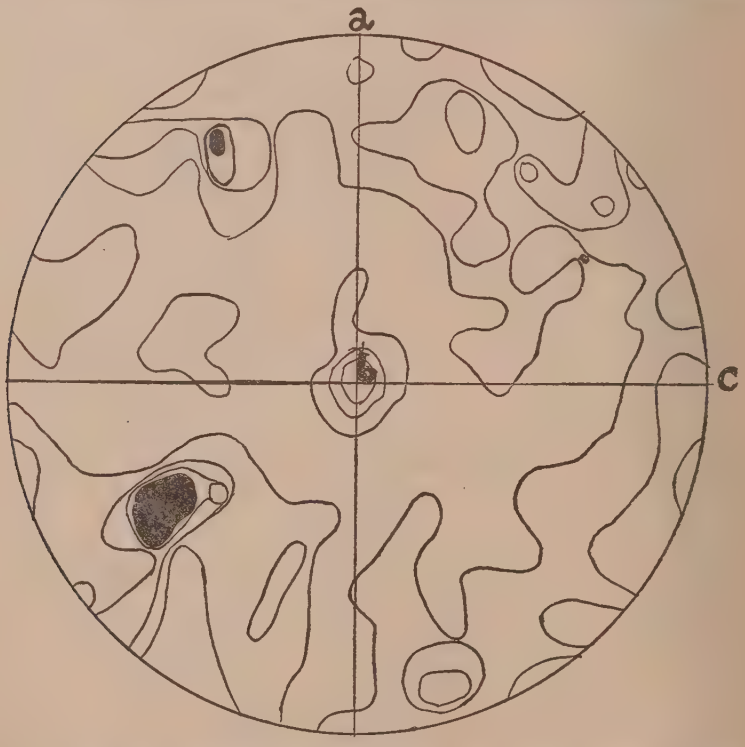

Fig. 3. Petrofabric diagram of a Migmatite. 200 quartz grains. Contour interval 1%. Maxima 4%.

Fig. 3 is the contour diagram of a migmatite which corresponds to the diagram above, namely I and V of Sander, with two pronounced maxima in the diagonal position and a series of minor maxima distributed along the partial girdle. The additional character of this diagram is that it has got a minor maximum in the centre

corresponding to maximum VIII of Sander. Such diagrams which have a combination of I, V and VIII, have been described by Hietanen (1938) in the Finnish quartzites. The girdle is a natural explanation of the fact that the migmatitic granite has got schistose character imposed upon it by the mafic inclusions: It may therefore be summed up that the petrofabric diagrams of the gneiss and migmatite of this area correspond to those of schistose and quartz-rich rocks.

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The author places on record his deep sense of gratitude to Dr. P. R. J. Naidu for suggesting the problem and guiding throughout the work.

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Some Minerals from the Calc-band of Sankaridrug, Salem District

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ABSTRACT

This paper deals with chemistry of minerals occurring in the main calc-band passing through Iveli, near Sankaridrug. The study includes the analyses of a pyroxene, a wollastonite and an amphibole.

Pyroxene

The chemical and optical studies of a pyroxene occurring in the calc-band near Iveli is given below. The pyroxene has been taken from almost pure pyroxene skarns occurring as veinlets in the quarry worked by Mettur Chemical Corporation, in Iveli. The pyroxene lenticles are thin up to a maximum, width of 3″ and only a few yards along their length. The pyroxene rock is hard, compact and dark green in colour. The pyroxene is associated with thin sheaves of biotite along the contact with the limestone. The limestone is mainly composed of pure coarse crystalline calcite, with occasional pockets of dolomite in the fine-grained varieties.

Under the microscope it is seen that this forms continuous well-knit plates, with inclusions of chlorite, scapolite and small crystals of calcite. The average grain size is 1·60 mm. × 1·50 mm. The pyroxene is not associated with any plagioclase.

The pyroxene has been chemically analysed and the Warren's formula has been calculated as follows:

Constituents	Wt. %	Mol. Prop.	Oxygen atoms.	Metal atoms.		Basis 6 (O, OH, F)		
SiO_2	42·74	0·712	1·424	Si	— 0·712	1·644		2·000
Al_2O_3	9·13	0·089	0·267	Al	— 0·178	0·411	0·356, 0·055	
TiO_2	0·08	0·001	0·002	Ti	— 0·001	0·002		1·103
Fe_2O_3	1·38	0·009	0·027	Fe'''	— 0·018	0·042		
FeO	5·59	0·078	0·078	Fe''	— 0·078	0·180		
MnO	0·08	0·001	0·001	Mn	— 0·001	0·002		
MgO	14·25	0·356	0·356	Mg	— 0·356	0·822		
CaO	24·52	0·438	0·438	Ca	— 0·438	1·012		1·040
Na_2O	0·32	0·005	0·005	Na	— 0·010	0·023		
K_2O	0·10	0·001	0·001	K	— 0·002	0·005		
H_2O+	0·91	..	..		..	..		
H_2O-	0·42	..	..					
Total	99·52		2·598					

$F = 6/2·598 = 2·410.$

Hence the Warren's formula for the pyroxene is:

$(Ca, Na, K)_{1·04}\ (Mg, Fe'', Fe''', Al, Ti)_{1·103}\ (Si, Al)_2\ O_6.$

The Niggli Basis is as follows:

Kp	0·33	Fs	1·51	Q	16·44
Ne	1·67	Fo	29·76	Q	16·44
Cal	13·88	Fa	6·63	L	15·88
Cs	29·70	Ru	0·06	M	67·66

When the Q.L.M. Values of the pyroxene are plotted in Niggli's diagram for pyroxenes (1945), the point falls just outside the field of common augites of eruptive rocks. The optical data of this pyroxene are given below:—

$2V_z = 58° — 60°$

$59°$ (average of 6 readings)

$Z\Lambda c = 44°$

$\gamma\text{-}\alpha = 0·029$

$\gamma\text{-}\beta = 0·020$

$\beta\text{-}\alpha = 0·008$

$Y = b\ \ XZ \parallel (010)$

Specific Gravity is 3·121.

Buddington (1950) has studied the chemistry of pyroxene skarns, from the anorthosite — marble contact zone of Adirondack. The analysis of one of these pyroxenes is as follows :-

SiO_2	..	45·30
TiO_2	..	1·30
Al_2O_3	..	7·74
Fe_2O_3	..	3·36
FeO	..	12·27
MnO	..	0·15
MgO	..	7·04
CaO	..	21·74
Na_2O	..	0·88
K_2O	..	0·16
H_2O+	..	0·39
H_2O-	..	0·06
	..	100·39

[Ferrosalite from feldspathic pyroxene skarn zone at contact with gabbroic anorthosite gneiss. (Analysts : R. B. Ellestad and Lee C. Peck. *Amer Min.* Vol. 35, 9 and 10, p. 66.)]

It is seen that the Sankaridrug specimen is rich in magnesia; while the Adirondack specimen is poor in this constituent, and rich in titania and ferrous iron. This is due to the fact that the Adirondack specimen is ferrosalite, while the Sankaridrug pyroxene is salite. It is also to be seen that the magnesian (dolomite) environment is reflected by the nature of pyroxene in Sankaridrug.

Wollastonite

Wollastonite occurring as small needles in the grossularite-Wollastonite rock has been separated and analysed to confirm its composition as inferred optically. Wollastonite occurs as white needles oriented parallel to the foliation of the rock.

Under the microscope these crystals range in size from 0·74 mm. x 0·32 mm. to 1·7 mm. x 0.94 mm. The pyroxene associated with this rock is colourless to pale green diopside with $+2V = 61°$ and $Z\Lambda c = 39°$. The garnet is massive, and is seen to be crushed in some places.

The chemical analysis is tabulated below:

Constituents	..	Wt. %
SiO_2	..	51·14
Al_2O_3	..	0·02
FeO	..	0·21
MnO	..	0·05
CaO	..	48·41
MgO	..	0·18
H_2O+	..	0·06
H_2O-	..	0·09
	..	100·16

The optics of the mineral is as follows:

$-2V = 38°$ $\quad X\Lambda c = 31°$

$XZ \perp (100)$ $\quad b = Y$

$\gamma - \alpha = 0·015$

$\beta = 1·632$

This is in agreement with the data reported from the following places:

	$-2V$	β	$\gamma - \alpha$
California	35°	1·629	0·017
Hungary	40°	1·633	0·014

Wollastonite is twinned on (100). The twins are simple, but there are some grains with lamellar twinning (Fig. 1). In a rare case in addition to the above, there is a twin plane (okl) the pole of which falls in the [(001) — (010)] zone.

It is to be noted that the mineral has only a trace of Al_2O_3, has a small percentage of magnesia and very little ferrous iron. Coomaraswamy (1900) has reported Wollastonites from Ceylon enclosing idiomorphic quartz, pyroxene and feldspar.

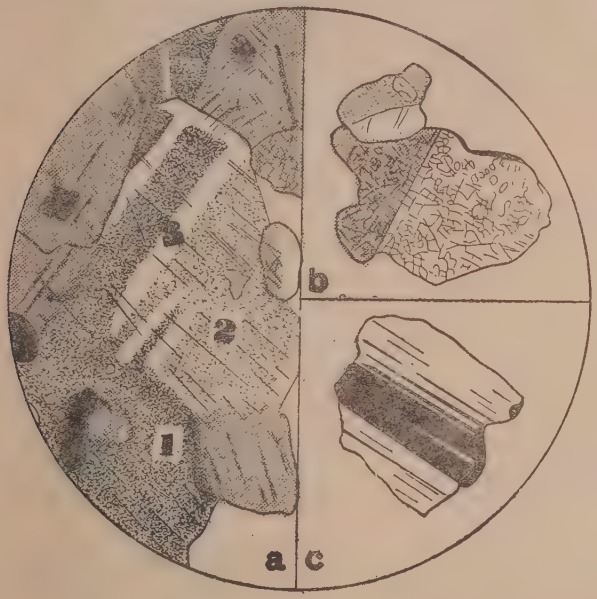

Fig. 1.

WOLLASTONITE TWINS × Nicols.

(a) Twins
1 and 2 — Parallel to (100).
2 „ 3 — Parallel (okl).
(b) (100) Twin — Section showing double cleavage — ⊥ to 'b'.
(c) (100) Lamellar twin.

The following are the results of the duplicate analyses of the Ceylon specimen as done by Shepherd.

	$\%_1$	$\%_2$
SiO_2	51·28	54·59
CaO	45·55	40·85
Al_2O_3	2·01	1·77
FeO	1·34	0·70
Loss on ignition	n.d.	2·29
	100·18	100·20

It is to be noted that there is alumina present in greater quantities than the Sankaridrug specimen. They occur in the charnokitic series and unconnected with any granite.

Hence it is inferred that there is a little Mg. replacing Ca, without any abnormal amount of ferrous molecule as has been reported by Tilley (1937). He has reported Wollastonite from Scawt Hill containing much ferrous molecule as inferred from optical data only. He does not give any chemical analysis.

Amphibole

A colourless *amphibole* occurring as thin radiating prisms in the calc gneiss of Iveli was separated, its optics studied and chemically analysed.

The tremolite-gneiss forms discontinuous bands in the main calc-band around Iveli, and in the exposure on hill △ 1492 W of Sankaridrug. The particular specimen analysed was taken in an exposure, S of milestone 251/3 on the Sankaridrug-Salem Road.

The colourless to pale green crystals ranging in length upto 3½″ are embedded in a matrix of crystalline limestone, composed of medium grained milky white calcite, with some flakes of brown mica associated with it.

The Warren's formula is calculated as shown below :

Constituents.	Wt. %	Mol. Prop.	Oxygen Atoms.	Metal Atoms		Basis 24 (O, OH, F)		
SiO_2	54·61	0·910	1·820	Si	— 0·910	7·777		
Al_2O_3	2·59	0·025	0·075	Al	— 0·050	0·416	0·223	8·000
							0·193	
Fe_2O_3	0·55	0·004	0·012	Fe	— 0·008	0·066		
FeO	0·54	0·007	0·007	Fe	— 0·007	0·058		5·256
MgO	23·71	0·593	0·593	Mg	— 0·593	4·939		
CaO	15·22	0·272	0·272	Ca	— 0·272	2·266		
Na_2O	1·09	0·018	0·018	Na	— 0·036	0·299		2.598
K_2O	0·17	0·002	0·002	K	— 0·004	0·033		
H_2O^+	1·50	0·083	0·083	OH	— 0·166	1·382		1·382
H_2O^-	0·04							
Total	100·02		2·882					

$$F = 24/2·882 = 8·328.$$

The Warren's formula is

$$(OH)_{1·382}\ (Ca, Na, K)_{2·598}\ (Mg, Fe'', Fe''', Al)_{5·256}\ (Si, Al)_8\ O_{22·618}.$$

Niggli Basis

Kp	0·64	
Ne	5·74	
		Q = 22·73
Cal	0·80	
Cs	22·35	
		L = 7·18
Fs	46·46	
Fo	0·60	
		M = 70·01
Fa	0·60	
Q	22·73	

When this value is plotted in the Q-L-M diagram of Niggli for Amphiboles, the point falls outside the field of amphiboles of eruptive rocks.

The optical data are as follows:

$-2V = 86°$ $\quad Z\Lambda c = 20°$

$\gamma-\alpha = 0·027$ $\quad \beta-\alpha = 0·012$

$\gamma-\beta = 0·015 - 0·017$

Specific gravity is 3·027.

According to Winchell, this mineral is Tremolite as the FeO content is less than 4%. The optical properties are in conformity with values given by Winchell (1924) for the mineral containing 0·5% of FeO.

The Winchell's metasilicate formula is given in the following table. It is compared with No. 5 of Winchell.

	Sankaridrug	No. 5 of Winchel
$CaO.\ MgO.\ SiO_2$	58·85	49·14
$CaO.\ (FeO.\ MnO)\ SiO_2$	—	0·58
$MgO.\ SiO_2$	32·40	39·40
$(Fe,\ Mn)\ O.SiO_2$	0·53	0·22
$H_2O.\ SiO_2$	2·88	4·83
$(Na,\ K)\ AlO\ (F,\ OH)_2$	4·32	—
$AlAlO_3$	0·51	1·30
$FeFeO_3$	0·64	0·18
	100·13	100·29
SiO_2 deficient	0·30	—
Na_2O deficient	—	0·23
Excess H_2O	—	0·04
	99·83	100·10

Hence the mineral is Tremolite with about 7% by weight of Ca Fe Si_2O_6. $Fe_2Si_2O_6$ according to Winchell.

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The Verbal Projection Test and the Estimates of Teachers and Parents

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ABSTRACT

This paper presents the results of a study directed towards verifying the hypothesis that an individual reveals his personality through any change he makes upon any type of material. 53 boys between ages 10 and 18 were used in this study. The Verbal Projection Test (V. P. T.)—a 'Projection Test'—devised by the investigator for use with adolescent boys in this part of the country—was administered to the subjects. From the stories collected from the test the dominant personality traits revealed by the principal characters were scored, with the help of a prepared list of personality traits with the same prepared list of personality traits, the subjects' teachers and parents were interviewed and their estimates of the subjects' dominant personality traits were obtained. When these different estimates were compared by using the χ^2 test of independence in contingency table first, and then contingency coefficient (C) it was found that the correlation between them was highly significant: $C = + \cdot 751$ for Teachers' estimates and parents' estimates $+ \cdot 716$ for Teachers' estimates and V. P. T. results and $+ \cdot 810$ for Parents' estimates and V. P. T. results. Thus the study confirms the hypothesis with which the investigation started.

Background of the Present Investigation:

Freud (1914) was the earliest amongst the Psychologists to suggest that an individual reveals his personality through any change he makes upon any type of material. Freud (1925) further elaborated this idea in his 'The Psychopathology of Everyday Life.' In this he has shown how ordinary instances of forgetting and slips of the tongue are in reality determined by the individuals' own personality. This idea has been further exemplified by Bartlett (1932) and Allport (1942). Allport, for instance, speaking of personal document defines it as 'any self-revealing record that intentionally or unintentionally yields informatian regarding the structure, dynamics and functions of the author's mental life. This

notion is implied in all 'Projective Techniques.' The 'Projective' techniques assume that an individual's responses to the unstructured test situations will reflect his own personality peculiarities. Seers (1946) writes: "Though the term Projective technique includes such widely varying methods and media as plastic materials, puppet shows, Rorschach Ink blots, the World Test and Doll Play, there is a common assumption underlying the use of all, viz., that, the individual, by his interpretation or organisation of the materials reveals his own thoughts, motives, understandings and emotions."

The Aim of the Study:

In this study an attempt was made to verify the assumption that when an individual interprets any material, he reveals his personality, by (1) finding out the degree of relationship between the dominant personality traits of the subjects as estimated by their teachers and parents, (2) the dominant personality traits of subjects as estimated by the teachers and as revealed by the principal characters in the stories written by the same subjects, in response to a 'Projection' test and (3) the dominant personality traits of subjects as estimated by the parents of the subjects and as revealed by the principal character in the stories of the same subjects written in response to a 'Projection' test.

Subjects:

The subjects were 53 boys from the 242 boys used earlier for another investigation (Shanmugam, 1950). Only in the cases of 53 boys could the investigator get relevent data for this study. The subjects' ages ranged from 10 to 18. They were of average intelligence and belonged to low socio-economic status.

Methods and Procedure:

The methods used were: 1. A Projective test, devised by the investigator for use on Adolescent boys; 2. interview of the teacher and 3. interview of the parents.

The projective test used was the Verbal Projection Test devised by the present investigator (Shanmugam, 1950) for use with adolescent boys. It consists of 20 items—19 armatures referring to different aspects of adolescent life and one item asking the subjects to write a story with a boy as the hero. The original test was in Tamil. An English translation of the test is given in the Appendix.

The estimates of dominant personality traits of the subjects were collected from their parents and teachers by interviewing them. The intimate knowledge a parent has of his son can be a safe guide. He knows his son's behaviour tendencies in different situations and can point out one particular trait or set of traits which may sufficiently characterise him. Similarly, knowledge about pupils acquired by a teacher who has worked for several terms and possibly for a few years with them, must be trustworthy. Cyril Burt (1945) found that the reliability of teachers assessment of personality traits was high, though reliability for the teachers' estimate for intelligence and special abilities was very low.

In order to estimate the dominant personality traits of the subjects, the list given below was used. The list of traits forms part of the main scoring scheme used by the author (Shanmugam 1950-51) for the analysis of the stories of the Verbal Projection Test. However, it was considerably modified for the present purpose. A copy of the scoring scheme with explanation of scoring is given in the Appendix. The list of traits contains two Sections—A and B. Under A, we have traits of mal-adjustment and under B traits of adjustment. The traits are roughly grouped and graded.

The List of Personality Traits

A. Traits of Maladjustment:

1. Easily discouraged and becomes despair.
2. Entertains hatred, revengeful, indulges in criminal acts, rebellious, violent, has suicidal tendencies.
3. Anxious, fearful, feels insecure, unhappy, suffers failures.
4. Suffers hardship, deprivation.

B. Traits of Adjustment:

1. Hopeful, courageous, confident, has faith, interest and curiosity.
2. Capable of loving, has attitude of reconciliation, peaceful, trusts others.
3. Joyful, successful, contented, feels secure, fearless and happy.
4. Easily attains, feels comfortable and encouraged.

The Verbal Projection test Stories of the subjects were analysed to see what dominant traits were revealed by the heroes of the stories. If the hero of the story revealed traits of hatred and violence, indulged in criminal acts, they were scored as A2. If the hero revealed courage and confidence, they were scored as B1. Finally out of 20 stories for each subject, the traits which appeared more frequent were considered as the dominant traits in those stories.

In the interviews with the teachers and parents, the general and special abilities and the intellectual status of the subjects were first enquired into. Then they were asked to give a general description of the behaviour of the subjects in different situations. Finally, the list of traits was shown to them and they were asked to mark that trait or traits which they considered as important in the subjects. It must be added that the interviews of the teachers and parents were not conducted specially for this purpose. When interviewing the teachers and parents, other details regarding the subjects were gathered for a different study.

Statistical Treatment of the Data:

In order to find out the degrees of relationship between these different estimates, first χ^2 test of independence in contingency table was used. When the χ^2 was found significant at 0·05 level of probability, contingency coefficient (C) was applied. Since there were eight groups of traits which were used in the study 8×8 fold table was used. The formula for χ^2 is as follows:

$$\chi^2 = \Sigma\left[\frac{fo - fe^2}{fc}\right]$$

in which

fo = frequency of occurrence of observed facts;

fe = expected frequencies of occurrence on the hypothesis.

Formula for C, the contingency coefficient, in terms of χ^2 is as follows:

$$C = \sqrt{\frac{\chi^2}{N + \chi^2}}$$

The results of the study are given in the following table. The contingency tables which will give an idea of the dispersion are given in the appendix.

TABLE giving the contingency coefficients for teachers and parents estimates. Teachers' estimates and V. P. T. results; and Parents' estimates and V. P. T. results.

Categories to be compared.	χ^2	df	Level of significance.	C	Significance
Teachers' estimate and Parents' estimate ..	163·866	49	·01 level	0·751	yes
Teachers' estimate and V. P. T. results ..	160·005	49	·01 level	0·716	yes
Parents' estimate and V. P. T. results ..	734·131	49	·01 level	0·810	Yes

A study of the above table will show that there is significant positive relationship between Teachers' estimates and Parents' estimates, Teachers' estimates and V.P.T. results; and Parents' estimates and V.P.T. results.

Discussion of the Results:

The results of the present inquiry confirm the assumption that when an individual interprets any material, he reveals his own personality. There is an important issue involved in this result. It is considered that when an individual estimates the personality of another individual, it is usually based on the overt behaviour of the individual, whereas, the 'projective' technique brings out materials from the 'deeper layers' of the mind—those things which he 'will not' and 'can not' say (L. K. Frank, 1939). In this case, we have found, though in a crude way, that there is correspondence between the Teachers and Parents estimate and the dominant personality traits as estimated from the stories of the subjects. There are two alternative interpretations that are possible: (1) The Verbal Projection Test brought out only the 'conscious' pre-occupations of the subjects which normally express themselves in the overt behaviour, and which behaviour may be observable by individuals closely connected with the subjects—the teachers and parents in this case, and 2. The Verbal Projection Test brings out materials from the 'deeper layers' of the mind, which, those who have intimate knowledge of the subjects—teachers parents—may have insight into, when estimating the behaviour of the subjects. One way of verifying this issue is to study the relationship

between the self-estimate of the subjects with those of teachers and parents. However, it may be indicated that the second interpretation may be true, because in an earlier study, the present investigator, (Shanmugam, 1951), when he used the Verbal Projection Test and the Thematic Apperception Test (T.A.T.) on the same subjects, he found that the results were basically congruent. It is an established fact today that the T.A.T. brings out materials from the deeper levels of mind.

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APPENDIX I

Table showing the scores under Teacher and Parents estimates and estimate on the basis of the V. P. T stories.

No. of subjects.	Teacher.	Parent.	VPT.
1	A2	A2	A3
2	A2	A2	A2
3	B4	A2	A3
4	B4	B2	A3
5	B4	B3	A3
6	A2	A2	A4
7	A4	B1	A4
8	A3	B1	A3
9	A3	A2	A4
10	A3	A3	A4
11	A2	A2	A3
12	A3	A2	A4
13	A4	B1	A2
14	B1	B2	B1
15	B1	B1	A4
16	B1	B3	B2
17	A3	A2	A4
18	A2	A2	B3
19	A3	A2	A3
20	A2	A2	A3
21	B1	A2	A4
22	B4	B1	A4
23	A4	A2	A4
24	A3	A2	A3
25	A4	A4	A3

No. of subjects.	Teacher.	Parent.	VPT.
26	A3	A3	A4
27	B3	B1	A1
28	A2	A2	B1
29	A2	A2	B2
30	A4	A2	A4
31	B4	A2	B2
32	B1	B4	B2
33	A4	A3	A2
34	A2	A2	A3
35	B1	B1	A4
36	A1	A2	B1
37	A1	A1	B1
38	A3	A2	A4
39	B1	B4	A3
40	A3	B4	A4
41	B1	B1	A4
42	A3	A2	A3
43	B2	B2	B1
44	A2	A2	A3
45	A2	A3	A3
46	B1	B1	A2
47	A4	A2	A3
48	A2	A2	A4
49	B1	B1	B3
50	B1	A4	A3
51	B3	A4	A4
52	A2	A2	A4
53	B1	A2	A3

APPENDIX II

Table of Coefficient of Contingency for the Estimates of Teachers and Parents

Parent

TEACHER	A1	A2	A3	A4	B1	B2	B3	B4	Total
B4	—	2	—	—	1	1	1	—	5
B3	—	—	—	1	1	—	—	—	2
B2	—	—	—	—	—	1	—	—	1
B1	—	3	—	1	5	1	1	2	13
A4	—	2	1	1	2	—	—	—	6
A3	—	7	2	—	1	—	—	1	11
A2	—	12	1	—	—	—	—	—	13
A1	1	1	—	—	—	—	—	—	2
Total	1	27	4	3	10	3	2	3	53

APPENDIX III

Contingency Table for Teachers' Estimate and V. P. T. Stories results

V.P.T.

TEACHER	A1	A2	A3	A4	B1	B2	B3	B4	Total
B4	—	—	3	1	—	1	—	—	5
B3	1	—	—	1	—	—	—	—	2
B2	—	—	—	—	1	—	—	—	1
B1	—	1	3	4	1	2	1	—	12
A4	—	2	2	3	—	—	—	—	7
A3	—	—	4	7	—	—	—	—	11
A2	—	1	6	3	1	1	1	—	13
A1	—	—	—	—	2	—	—	—	2
Total	1	4	18	19	5	4	2	—	53

APPENDIX IV

Contingency Table for Parents Estimate and V.P.T. Story results

TEACHER	A1	A2	A3	A4	B1	B2	B3	B4	Total
B4	—	—	1	1	—	1	—	—	3
B3	—	—	1	—	—	1	—	—	2
B2	—	—	1	—	2	—	—	—	3
B1	1	2	1	5	—	—	1	—	10
A4	—	—	2	1	—	—	—	—	3
A3	—	1	1	2	—	—	—	—	4
A2	—	1	11	10	2	2	—	—	26
A1	—	—	—	—	1	—	1	—	2
Total	1	4	18	19	5	4	2	—	53

V. P. T. Estimate

APPENDIX V

The Verbal Projection Test

Armatures:

1. While other boys are playing, one boy is standing in a corner.
2. A boy is walking in a narrow street looking behind often.
3. A boy is lying on a couch with his eyes closed. Sitting beside him is an elderly man.
4. Figures of two boys standing naked are seen in the darkness.
5. A winding road is between two high hills; a dim figure is seen in the distance.
6. A girl is walking along with books in her hands; Boys are looking at her.
7. Brother and sister are together. A grey haired man is standing near a window with his back turned towards them.

8. Teacher is conducting a class. One boy is inattentive.
9. It is mid-night; a figure is seen walking in the distance.
10. A boy is standing in a crowded place and is staring at the people.
11. In the operation theatre, a figure is found lying; instruments are there.
12. A boy is cloutched from behind by some people, who are not visible.
13. A boy is hesitatingly standing outside a temple.
14. Father and son are facing each other. Father is with a stern face; Mother is by their side.
15. A boy with books in his hand, is hesitatingly leaving a field where people are ploughing.
16. A boy is rolling on his bed without sleep.
17. Mother embracing her child, kisses it; Father is present. A boy is looking at them.
18. A boy, standing on a bank of a river, is looking at the still waters.
19. A corpse is being taken, a boy is looking at it.
20. A story with a boy as a hero.

The verbal Projection Test is a group test, in the present case, given to a group of adolescent boys from low socio-economic families in the city of Madras. The test was given to a group of ten boys at a time. The twenty items, called 'armatures' were administered in three sessions—in the first session six armatures, and in the subsequent sessions seven armatures each time. The interval between each session on an average was four days. The test was conducted in the regular class room where the subjects were studying. After administering the test, the subjects were interviewed individually to verify details left incomplete, vague and ambiguous by subjects.

Each individual was given an answer sheet. He was asked to mention his name and the date of the day; other details about him were collected earlier. After filling in these details, the subjects

were asked to keep themselves ready to receive instructions. The instruction given is as follows:—

> "I am going to give you a series of items, referring to situations and I want you to make up a story around each one of them. I want you to tell me what the events were that led up to it, what the feelings and thoughts of the characters were at that moment and what would be the outcome. The time given is four minutes for each item. You do not bother about the spelling or grammar mistakes or neatness of your handwriting. Just write as fast as you can. However only the essential plot need be given, avoiding elaborations."

The above instructions were repeated twice and also repeated on request in an abbreviated form to the subjects who did not follow them. The abbreviation was in this form:

> "What is happening? What led up to it? What will be the outcome? What were the feelings and thoughts of the characters at that moment?"

In the subsequent sessions, the instructions of the first session were repeated and some more were added: They are:—

> "The procedure today is the same as before. Only this time you can give free reign to your imagination. Your first six stories were good. Now I would like you to do your best."

The instructions for the last item of the test were slightly different. They were as follows:—

> "You have been giving interesting stories, full of imagination all these days on the basis of situations given by me. Now try a slightly different story. This time, you yourself, imagine a plot around a boy and build a story. Remember in this story also you have to mention those details you mentioned in the previous stories, namely, 'What is happening to the boy? What led up to it ? How it will end?"

Now Be Ready.

The obtained data was scored with the help of the analysis scheme.

An example of the analysis and score is given below:

Example Story:

"The boy is lying on his bed without sleeping. He cannot sleep. He has not had his food. He is having gnawing pains in the stomach. He is poor and has no father. How could he have food? He has to steal and eat and that is the only way. He might steal that night and eat from a neighbouring house."

In scoring a given story, if there are indications of more than one need, both the needs may be recorded. In this story, Sensory gratifications, such as sleep and hunger and belongingness need (as revealed by the statement 'he has no father') may be brought under the need column I as CE. Influence of environment may be considered as oppressive—economic (A 4) under category II. 'The boy is poor,. How can be have food etc.' may be considered as the reaction of the individual (hero); it may be scored as 'Ambivalent, Anxiety etc. (4) under Category III. Under the Category IV denoting adequacy level of the principal characters, item 4, (Hardship, deprivation, etc.) may be marked. The ending V is unfavourable to the individual and the society. So A. Thus, the scoring for the above story will be

I CE — II A4 — III A4 — IV A4 — VA

The above procedure is adopted for analysing and scoring the stories of the V.P.T. After scoring the stories this way, the relevant portion for us, for the present purpose, namely Category IV alone was considered. The score under this category was used in this paper, as denoting the dominant personality traits of the principal characters in the stories.

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A Modified Heterodyne Apparatus for Dielectric Constant Measurements

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ABSTRACT

A circuit of the modified apparatus for the measurements of the 'dipole moments' in solution by the 'heterodyne-beat' method is given, where the whole apparatus along with the 'Precision Variable Condenser' is kept at the same temperature at which the principal thermostat is maintained. By such an arrangement any difference between the capacity of the 'Precision Variable Condenser' and the dielectric constant cell' due to a difference in temperature is eliminated, and an accuracy of 0·0005 units is claimed over small dielectric constant ranges (1·5-4·5D) with weight fractions of 0·005-0·05.

In the study of dipole moments for the elucidation of structures of some compounds, the individual observations made are the dielectric constant, density, refractive index and the concentration of the molecular species under examination.

The two principal methods of measuring the capacity of a condenser and hence the 'dielectric constant' of the substance filling the condenser are the 'Capacity Bridge' method, and the resonance or 'heterodyne — beat frequency' method. One of the earliest attempts to construct an instrument of the 'heterodyne type' was made by Zahn (1924) and this battery-operated apparatus was later improved upon by Stranathan (1938) for the elimination of frequency drift in the oscillators. Hudson and Hobbs (1942) by designing a new and well balanced circuit incorporated certain improvements over Stranathan's a.c. operated portable apparatus. The main features of their design were a power supply with a line voltage stabilizer and the thermostating (Coop & Sutton, 1938) of the oscillators to prevent any frequency drift due to humidity or temperature variation, thus attaining a high degree of stability. Recently entirely new designs for the apparatus have been described by Smyth (1949), Jen-Yuan Chien (1947). Goldsmith &

Wheland (1948), Few Smith & Witten (1952) and Henderson & Taylor (1953) where recent developments in tube designs are taken advantage of, in a circuit designed for oscillator stability, with a visual beat-note indicator.

The apparatus constructed here follows of Jen-Yuan Chien's (1947) design with certain modifications. The circuit diagram is shown in figure 1. The fixed frequency signal generated by a crys-

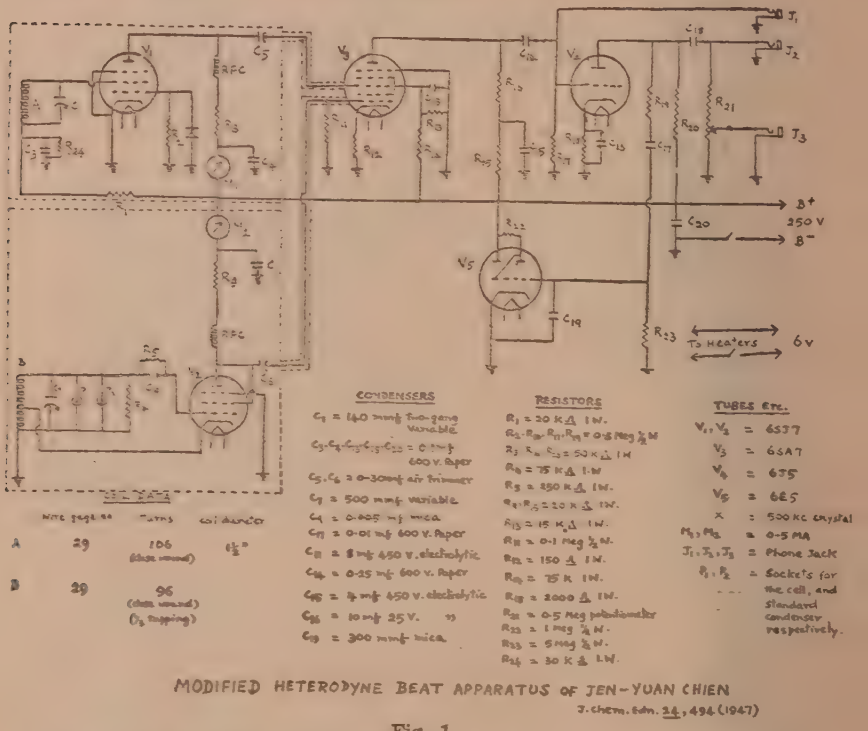

Fig. 1.

tal-controlled oscillator, using a crystal of 500 Kc having a tolerance of 1 cycle per Megacycle per second, is a conventional one. The frequency is such that it is high enough to give adequate sensitivity, but, low enough to ensure that the total inductance needed to resonate with the capacitance to be measured is small compared with lead inductances. An r.f. choke is included in this part of the circuit to prevent any stray r.f. currents from entering into the circuit. With full capacitance in, the plate circuit is off the scale of the milliam meter: as the capacitance is reduced a sharp dip in the plate current to about 1·5 mA occurs as oscillations set in. The

capacitance is still further decreased until the plate current rises to a maximum of 2 mA at which point the oscillator is found to be more stable.

The variable frequency oscillator, of the conventional 'Hartley' type, employed here, is different from the original, in that another 6SJ7 type tube, is used in the circuit instead of the 6A8 type pentagrid converter tube, even inspite of the author's (Jen-Yuan Chien 1947) claim that this type of tube is mainly responsible for the unusual stability of the oscillator. The reason for such a change is two fold; first by using a 6SJ7 type tube, effects of the cathode temperature upon the frequency, which generally is very great, is almost completely eliminated (Hudson and Hobbs, 1942) and secondly by using such a type of tube in this circuit as in the crystal controlled oscillator part, the two circuits are balanced, where any change in the tube characteristics or supply voltages affect their frequencies identically and do not result in an error due to frequency drift (Hill and Sutton, 1953); (Conradi and Li, 1953). Further balance is achieved by using another r.f. choke in this circuit too, to cut off any stray r.f. currents. A milliammeter is included in this part of the circuit also to indicate whether the oscillator is on or off the point. The two oscillators, the amplifier and the Precision Variable Condenser are all shielded properly and earthed to a common terminal.

A definite improvement over other methods effected here is the 'thermostating' of the two oscillators with the amplifier unit and the 'Precision Variable Condenser' to the same temperature at which the 'dielectric constants' are measured, as this arrangement avoids any difference between the capacity of the 'Precision Variable Condenser' and the 'dielectric Constant cell' due to differences in temperature. The whole apparatus is switched on, to warm up full two hours before any dielectric constant measurements are made, so that there is negligible drift in the beat note.

The complete apparatus and the principal thermostat in which the 'dielectric constant cell' of 'Sayce-Briscoe' type is immersed, are both maintained at $32 \pm 0{\cdot}01°C$ or even better by the use of the 'Simple and Inexpensive Electronic Relay' (D. Sethu Rao and Anantakrishnan, 1954) specially designed for the purpose. Liquid paraffin of low dielectric constant (2·3) is used as the thermostat liquid because when liquids of high dielectric constants and conductances, such as water, are used, electrical leakage from the cell often results, in introducing errors (Shedlovsky, 1949). The cell is silvered (Sugden, 1933) to the required height and standardized by using

very pure samples of Benzene and $CC1_4$ with aid of the formula given by Le Fevre (1953). Evaluation of the 'dielectric constant' of any solution is then made with the 'cell', using the equation of Everard *et al* (1950).

The following table giving the dielectric constants of pure samples of Benzene and $CC1_4$ shows the accuracy of the measurements and incidentally the realiability of the set up of the apparatus for other measurements as well.

TABLE I.

(Absolute dielectric constant values at $32 \pm 0{\cdot}01°C$)

Substance	Dielectric constant observed.	Dielectric constant from literature:
Benzene	2·2588	2·2620 [Hartshorn & Oliver (1929)]
$CC1_4$	2·2155	2·2160 [Heston & Smyth (1950)]

I have to thank Dr. S. V. Anantakrishnan, Professor of chemistry for his guidance and the Government of India for a scholarship that enabled me to take up the work.

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The Heavy Accessories of Chamundi Granites and Gneisses, Mysore, Mysore State

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ABSTRACT

The present contribution deals with the heavy accessories of "Chamundi Granites & Gneisses", their distribution and variation. The frequencies are estimated and represented after Evans, Hayman, Majeed (1934), and also after the manner of Stark & Barnes (1935). An attempt has been made to correlate these rocks with Granites and Gneisses of Cuddapah. From the study and comparison of the heavy accessories of these two suites of rocks we find, that while the Cuddapah Granites are essentially hornblende Granites and are trondhjemitic in character (Naidu 1954), the Chamundi Granites are chiefly mica Granites. Though most of the other heavy minerals are common between the two areas, garnet is absent in the Cuddapahs. The association of biotite-garnet places the Chamundi granite at a higher grade of metamorphism than the Cuddapah Granites.

Introduction

The study of heavy accessories in igneous rocks, by means of concentrations of the heavy fractions is fairly a recent advancement in petrology. The possibility of these heavy accessories of igneous rocks as the criteria for purposes of correlation has evoked increasing interest within the last few years. The present paper deals briefly with the study of heavy accessory minerals of Chamundi rocks, their variation and distribution. An attempt has been made to correlate Chamundi rocks with other Granitic rocks of possibly similar age based on the study of heavy accessories.

Methods Employed

The method is mainly modelled on the lines suggested by Groves (1927A, B1930). The specimens for the study of heavy accessories were chosen to cover as wide a range of texture and mineral composition as possible.

Twenty samples of Granites and three samples of gneisses collected from Chamundi hills (Long 76°40′ 12°15′ Lat) were sub-

jected to heavy mineral analysis. The distribution of the rock types is shown in the map.

The samples were crushed to pass through 40 mesh sieve, and then through 60 mesh sieve. The +60 mesh fraction was retained for heavy mineral analysis. Hundred grams of each sample were washed free of dust and rock flour, and finally dried on a sand bath.

Twenty grams of this prepared material were treated with bromoform of Sp. Gr. 2·9, and the heavy residue obtained was washed free of bromoform with benzene, and dried on a hot plate. Much of the mica which floods the sample was removed by beauritising as suggested by Groves (1927). The heavy fraction thus obtained and expressed as a percentage is the "Index figure" to which Groves attaches considerable importance. The heavy crop was next resolved into magnetic and non-magnetic fractions by means of an horse-shoe magnet. Both magnetic and non-magnetic fractions are mounted, but where the heavy residue obtained was unwieldy, it was suitably sampled by coning and quartering and then mounted. Counts of not less than 300 grains have been made for purposes of frequency estimations. The Index figures were calculated after Groves (1927). The frequency estimations in different types are presented in Table I.

Porphyritic Granite:

It occupies much the larger portion of the area. It is confined mostly to the foot of the hill extending only for some distances into the flanks. Both pink and grey porphyritic granites are present here, the colour of the granite is much dependent upon the felspar present. The grey variety of porphyritic granite is more extensive than pink. The felspar phenocrysts are embedded in a coarse grained matrix composed of quartz, felspar, and biotite. Five specimens have been crushed for study. Index figure varies from (7-10). The heavy minerals consist of epidote (17·67%), sphene (8·49%), as the maximum, zircon (2·29%), apatite (3·29%) and rutile (0·86%) as the least.

Grey Granites:

They are found higher up on the flanks of the hill. They are fine to medium grained, light to dark grey in colour, mainly composed of quartz, felspar and biotite. Biotite shows a tendency to occur as elongate flakes. Five specimens were crushed for study. The Index figure varies from (5-8). The heavy suite consists of epidote (14·79%), as the maximum and garnet (7·44%), zircon (1·06%), apatite (1·73%) and rutile (1·33%).

TABLE I

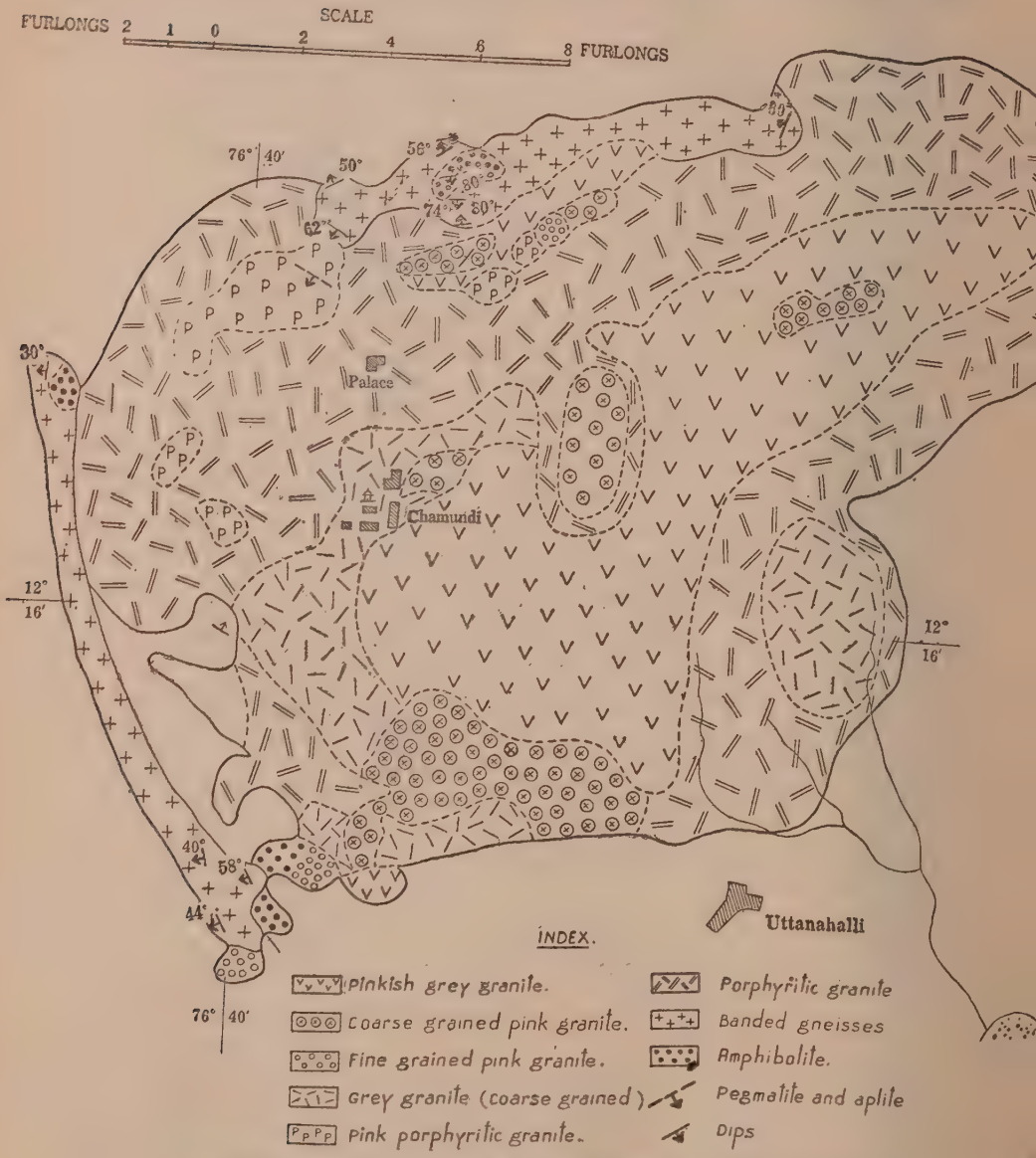
FREQUENCY CHART (After P. Evans, Haymen and R. J. Majeed) *Quart. Journ. Geol. Min. Met. Soc. India.*, 1934, Vol. 6, 40-41.

Rock types	Normal Accessories									Pneumatolitic Accessories		Secondary Accessories						
	Biotite	Hornblende	Zircon	Apatite	Sphene	Pyrite	Magnetite	Ilmenite	Garnet	Rutile	Anatase	Chlorite	Epidote	Zoisite	Clinozoisite	Muscovite	Haematite	Leucoxene
1. Porphyritic granite ..	6	—	2	3	5	—	6⁻	4	—	1	1*	5	6⁻	4	—	4	—	4
2. Grey granite ..	5	—	2	2	4	—	6⁺	4	6⁺	1	1*	4	6	4	3	4	—	5
3. Pink granite ..	5	—	2	3	3	—	6⁻	4	5	1	1*	5	5	4	—	5	—	—
4. Pinkish-grey granite ..	6⁻	—	1	2	4	—	6⁻	5	5	1	—	5	6⁻	4	—	4	5	5
5. Gneiss ..	7	6⁻	1	3	—	5	5	—	—	—	—	5	1	—	—	—	3	—

LEGEND FOR TABLE I.

8⁺	90-100%	7⁺	48-59%	6⁺	23-27%	5	7-13% Very common.
8	75- 89% Very abundant.	7	35-47% Abundant.	6	18-22% Fairly abundant.	4	4- 6% Common.
8⁻	60- 74%	7⁻	28-34%	6⁻	14-17%	3	2- 3% Fairly common.
						2	1- 2% Scarce.
						1	½- 1% Rare.

1* One or two grains or less than ½%.



MAP SHOWING THE ROCK FORMATIONS OF CHAMUNDI HILLS, MYSORE

Pink Granites:

They are well exposed on the southern extension of the hill. They are hard, compact, fine grained rocks with quartz and felspars as the only constituents present, to the total or almost total exclusion of mafic minerals. Five specimens were crushed for study. Index figure varies from (1-2·5). Heavy suite consists of epidote (10·4%), garnet (8·25%), sphene (3·01%), zircon (1·86%), apatite (2·05%) and rutile (1%).

Pinkish-Grey Granite:

These are fairly extensive and are exposed at the top of the hill. It is a coarse to medium grained rock which varies from light to dark pinkish-grey in colour, and exhibits crude banding occasionally. Five specimens were crushed for study. Index figure varies from (9·5-12). The heavy suite consists of epidote (14·79%), sphene (5·80%), garnet (7·44%), zircon (1·06%), apatite (1·06%) and rutile (1·33%).

Gneisses:

These are found at the foot of the hill. They are well banded, with alternate bands of dark and light material. The dark bands are composed of hornblende and biotite, and light bands of quartz and felspar. There are textural gradations from crudely banded to fine banded gneisses. Three samples were crushed for study. Index figure is very high (23). Pyrite (8·64%), apatite (2·54%), zircon (0·63%) and epidote (0·83%) constitute the heavy suite.

Heavy Minerals

The following are the minerals that constitute the heavy fraction of the residue, with their characters.

Magnetite:

It occurs as irregularly fractured grains (0·88m.m. × 0·52m.m.) often associated with quartz. It often shows a coating of red ferruginous matter.

Ilmenite:

It also occurs as irregularly shaped grains (0·57 m.m. × 0·52 m.m.) associated with quartz, and is often found coated with Leucoxene.

Zircon:

This is occasional in its occurrence. It occurs as euhedral and rounded grains (0·20 m.m. × 0·16 m.m.). They are colourless,

and some with pale brown colour. Most of them are characterized by inclusions.

Apatite:

It occurs as, colourless or slightly yellowish grains (0·28 m.m. × 0·19 m.m.) with prismatic rounded terminations. Inclusions were fairly common.

Sphene:

It occurs as well developed grains (0·48 m.m. × 0·36 m.m.) and also as regular fragments without crystal faces. Some of them are euhedral and wedge shaped. They range in colour from yellow to yellowish-brown. Inclusions were found in some individuals. Some of the coloured types were pleochroic in brownish tints. They also exhibit interpenetration twins occasionally.

Epidote, Zoisite, Clinozoisite:

All these three minerals are present. However it was not possible always to distinguish between them. Epidote was pistachio green in colour, sometimes colourless and some of them were yellow and brown. Altered grains consisted of a mixture of epidote and felspar, thereby showing that it is secondary in its origin. Zoisite was distinguished from epidote by its high order blue polarisation colour, and from clinozoisite by the property of straight extinction. The average grain size of epidote is (0·30 m.m. × 0·17 m.m.) and zoisite (0·20 m.m. × 0·15 m.m.).

Garnet:

It occurs as well formed, euhedral grains and rounded grains. (0·44 m.m. × 0·32 m.m.). It ranges in colour from colourless to pale brown or pink. It has high relief and is isotropic.

Pyrite:

It is found only confined to gneisses, and occurs as opaque grains (0·19 m.m. × 0·14 m.m.). Under reflected light, it displays yellowish colour. It is found coated with red film here and there (haematite?).

Rutile:

It occurs as rounded grains (0·23 m.m. × 0·16 m.m.). The colour ranges from pale brown to deep brown, and sometimes red. Some of them show geniculated twinning.

Biotite in the case of granites and hornblende in the case of gneisses floods the sample. Importance has been attached only to the true accessories.

From the above studies we find that there is no marked fluctuation among the different types in the distribution of the heavy accessories, except garnet, which is absent in porphyritic granite. They are found uniformly distributed throughout with no striking variations.

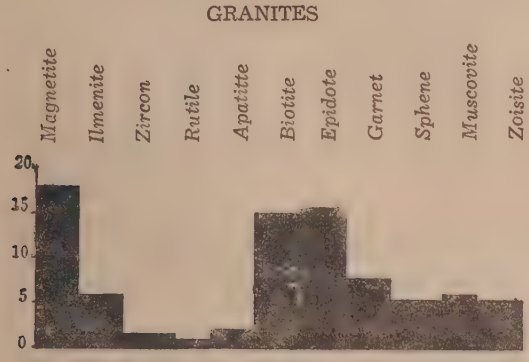


Fig. 1(A).
Histogram showing the distribution of heavy accessories in Chamundi Granite.

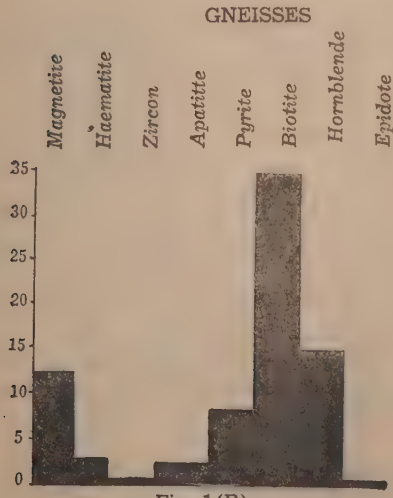


Fig. 1(B)
Histogram showing the distribution of heavy accessories in Gneisses.

The relationship among the heavy mineral assemblage of the granites and gneisses of Chamundi is shown by histograms (p. 297). They are also represented graphically for purposes of comparison Fig. 2(A) and (B), together with the heavy mineral assemblage of the granites and gneisses of Cuddapah after Stark and Barnes (1935).

CHAMUNDI GRANITE

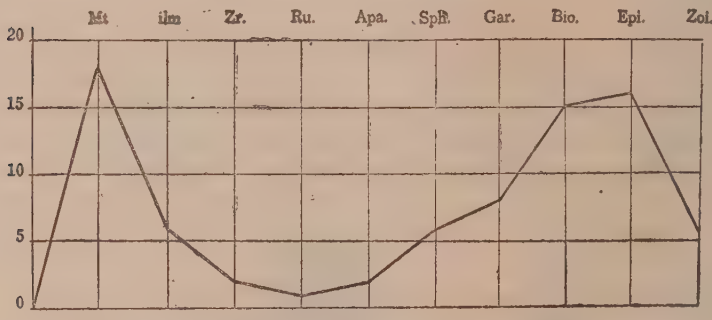


Fig. 2(A).

Index: Mt—Magnetite, Ilm—Ilmenite, Zr—Zircon, Ru—Rutile, Apa—Apatite, Sph—Sphene, Gar—Garnet, Bio—Biotite, Epi—Epidote, Zoi—Zoisite.

CUDDAPAH GRANITE & GNEISS.

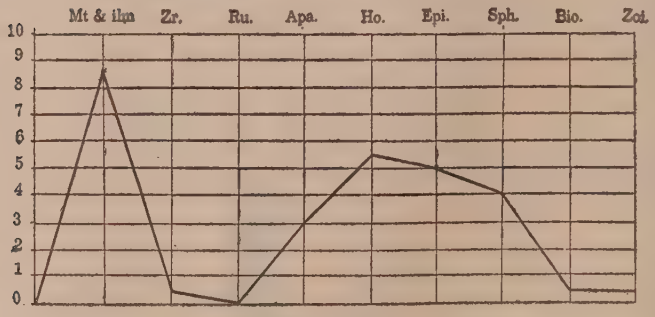


Fig. 2(B).

Index: Mt & Ilm—Magnetite & Ilmenite, Zr—Zircon, Ru—Rutile, Apa-Apatite, Ho—Hornblende, Epi—Epidote, Sph—Sphene, Bio—Biotite, Zoi—Zoisite.

When a comparison of the heavy minerals of the "Chamundi Granites" is instituted with granites and gneisses of Cuddapah, we notice that there is much in common between the two rock suites excepting for some minor variations.

Comparison between the Heavy Mineral Assemblage of Granites and Gneisses of Chamundi and Cuddapah.

	CHAMUNDI.	CUDDAPAH.
1.	Mineral assemblage is complex, e.g., magnetite, ilmenite, zircon, apatite, epidote, zoisite, sphene, biotite, hornblende, rutile, garnet.	Mineral assamblage is complex, e.g., magnetite, ilmenite, zircon, apatite, epidote, sphene, zoisite, biotite, hornblende, rutile.
2.	Iron ores are fairly abundant. Biotite also abundant and floods the sample. Sphene is fairly common to very common. Epidote fairly abundant to abundant. Apatite is fairly common to scarce. Zircon is scarce or rare and mostly represented by less than ½%. Rutile is also present scarcely.	Iron ores most abundant. Epidote and hornblende are abundant to common. Sphene and apatite are common to scarce. Zircon is represented by a grain or two or less than ½%. Rutile and tourmaline are very scarce.
3.	Zircons are mostly colourless or pale brown in colour, occurring as rounded and euhedral crystals with inclusions. Some exhibit faint zoning.	Zircon is of pink or brown tinted variety, small in size and euhedral in many instances. Opaque inclusions rendering grains dusty are abundant. A few of the grains show feeble zoning.
4.	Apatite is mostly colourless or yellow in colour, often rounded, some of them prismatic.	Apatite is of colourless, rounded grains with prisms and rounded terminations are common forms.
5.	Biotite is the flooding mineral with hornblende, sphene, epidote, being abundant.	Hornblende is the flooding mineral with biotite, sphene, epidote being abundant.
6.	Garnets are abundant in "Chamundi Granites". Muscovite is also fairly common to common.	They are absent in Cuddapah Granites and Gneisses.

From the above comparison we find that both the assemblages are similar in some respects but differ in others. The age of the Cuddapah granites and gneisses have been fixed as definitely "*Precuddapahs*" from field studies by Ramaswamy (1951) and from the study of heavy minerals by Gundu Rao (1953). Since the heavy suite of Chamundi rocks does not resemble the Cuddapah granites and gneisses, its age cannot be fixed as pre-Cuddapah, based on the study of heavy minerals.

Nockolds (1931) in his study on contaminated granites of Dhoon (1931) and Alderney (1932) has suggested that the occurrence of biotite, sphene, hornblende, accompanied by felspars and quartz containing inclusions of apatite, sphene, epidote are charac-

teristic of contaminated granites. Very recently Raghavan (1955) in his study on heavy mineral suites of granites of Jalarpet has drawn the same conclusion, as envisaged by Nockolds (1931) from the study of heavy accessories.

The granites and gneisses of Chamundi are abundant in sphene, biotite, and epidote. Thus from the study of the distribution of the heavy minerals, it can be concluded, that the granites and gneisses are contaminated by amphibolites and hornblende schists, a conclusion reached otherwise by field evidence.

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Variations in the Fat Content of the Muscles of the Ribbon Fish, *Trichiurus haumela* (Forskal) *

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ABSTRACT

Both the immature and maturing *Trichiurus* exhibit periodic variations in muscle fat value. These are partly determined by changes in the quality and quantity of food consumed.

Within certain limits, fat value increases with length.

Changes in size-composition have some influence on the monthly fat values of the immature stock, but have no significant effect on those of the maturing group.

There is some evidence to indicate that the drop in fat content of the maturing group observed during the January-April period is, to some extent, related to the development of the gonads.

The author (Sekharan 1949, 1950) has previously reported on the periodic variations in the fat content of the muscles of two plankton feeders, viz., *Dussumieria acuta* (Guv. and Val.) and *Pellona hoevenii* (Blkr.). This study deals with a carnivore *Trichiurus haumela* (Forskal), the most common ribbon fish of the Madras coast. Off Madras, it occurs in dense shoals during the period September to December, preying on post-larval and adult teleosts and the larger crustacea. From about January onwards there is decline in their abundance in the areas normally covered by the local fishermen. An account of the biology of this species has recently been given by Prabhu (1955). According to him the fishery of the Madras region comprises four age-groups, viz., 1- to 4-year olds; spawning takes place in offshore waters in the month of

* Formed part of a thesis awarded the degree of Master of Science by the University of Madras.

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June. Vijayaraghavan (1951) has investigated the food and feeding habits of the fish and Mahadevan (1950) has described the histology of the alimentary tract. Some amount of work on the biology of the fish has been done on the West coast also. (See Prabhu, 1955, for literature concerning the species).

Material and Methods

Ribbon fish are caught in Madras in boat-seines and shore-seines; only the latter land their catches in fresh condition, and so the material for this study was collected only from them. The samples were obtained, from the landing place itself, usually once a week, during the period August 1948 to June 1949 and August 1949 to June 1950. In the laboratory the gonads and alimentary canal were dissected out and the fish preserved in 10% formalin wherein they were kept for 7-10 days. The gonads were weighed after removing the excess body fluids by a filter paper and then preserved in 5% formalin. The classification of maturity stages was modelled after the standards adopted by the International Council for the Exploration of the Sea; the weight of the gonads served to support this. The alimentary canal was also preserved in 5% formalin for a later study of the contents. On a preliminary examination, it was seen that the fish feed mainly on teleosts and larger crustaceans. As only broad groupings were necessary for purposes of this investigation, the stomach contents were classified into (a) crustacea, (b) teleosts and (c) the rest including digested matter. The volumes of these categories were also determined, usually by the displacement method.

The main method adopted for the assessment of the fat content of the muscles was the histological technique recommended by Wilson (1939), whereby the fatness of a fish is judged by the extent of the area stained in a slice taken from it. That portion of the body which gives the best picture of fat when stained is determined first. From a comparative study of the slices of this part prepared from a large number of fish, different degrees or grades of fatness are defined. In subsequent analyses of samples every individual is allotted one or the other of these fat degrees. To make the fixation of fat values less arbitrary, the following procedures were adopted: (1). The area of the most prominent, stained regions in a slice was measured by a net-micrometer under a constant magnification (6×3) and expressed in terms of a slice of standard dimensions (height 100 mm, width 50 mm). Thus, the range of

variation in the area of the relevant fatty regions in slices of different fat degrees could be determined. (2). After taking a slice and preserving it in 10% formalin, a sample of body muscles was prepared from a fresh fish and the fat extracted chemically, first with redistilled rectified spirit and then with ether. Repetition of this experiment gave the range of fat values indicated by the different fat degrees (see table1). The advantages of the methods described above over procedures which depend purely on chemical extraction are obvious. (For further details of techniques adopted, see Sekharan 1949 and 1950).

Distribution of adipose tissue

As mentioned earlier, attention here is confined mainly to fat stored in and around the body muscles. Of the fat-storing tissues, the most prominent ones are situated above the neural spine and a little way down from the upper tip of the slice. In this region can be distinguished (a) a lower triangular area (b) a club-shaped area above it and (c) a more dorsal coloured patch on either side of the median septum. The total area of these tissues exceeded that of others in slices taken from fishes of different fat degrees, and they also could be conveniently measured. Hence only these tissues were taken into account when calculating the area of fat-spread.

Among the other sites of fat storage, the muscle at the top of the slice which is divided by a septum into a crescent-shaped part above and a small circular portion below is noteworthy. In fish of poor fat content the two parts are distinct, but with increased accumulation of fat in the muscles, they merge into one another (see fig. 1). Sub-cutaneous fat is not well developed in the ribbon fish. It is arranged in very small patches opposite the septa that divide the laternal muscles. Adipose tissue also extends along the septa that traverse the muscles in upper region of the slice. In addition to these, the centrum and the arches above and below it reveal coloured patches.

Fat degrees: A preliminary examination showed that as in the case of the flounder (Wilson 1939) slices taken from the widest part of the body midway between head and tail gave the best picture of fat. The two faces of a slice varied little with regard to the general appearance of fatness, nor did sex make any marked difference. After a careful and repeated comparison of slices prepared from different samples, it was seen that the individuals comprising

the population could be graded into eight degrees of fatness. Typical slices representing the different fat degrees are illustrated in fig. 1. In table 1, the second column gives the area of the median dorsal

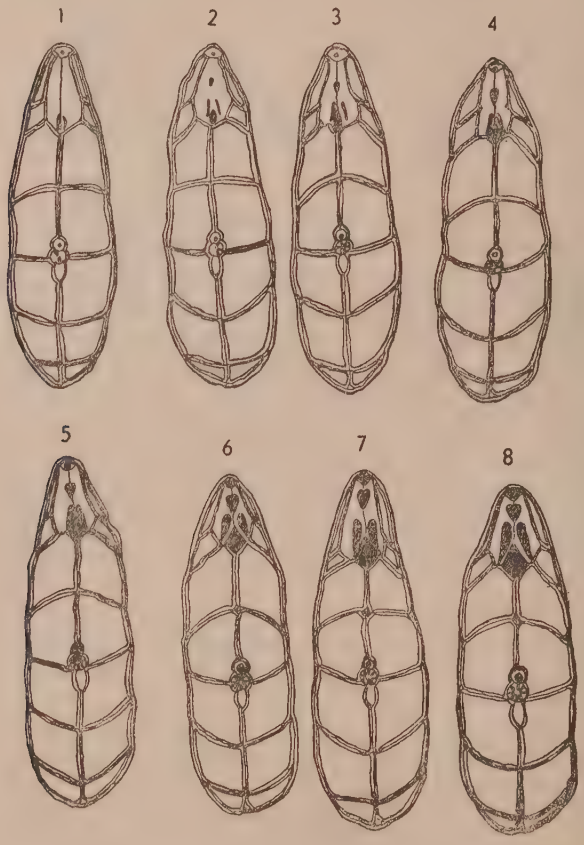

Fig. 1.

Diagramatic representation of typical slices of the ribbon fish of different fat degrees. (The numbers refer to fat degrees)..

stained region measured under a magnification of 6 × 3 and expressed in terms of a slice of standard slice. The amount of fat present in fishes of different fat degrees, as determined by chemical extraction, is shown in column 3.

TABLE 1

The relation of fat degrees to (1) the area of the median dorsal adipose tissue in a slice of standard dimensions (100 mm. 50 mm.) and (2) to the amount of fat as determined by chemical extraction.

Fat Degrees	The area of the median dorsal adipose tissues. (Measured under the magnification, 6 × 3, and expressed in terms of the number of squares of the net-micrometer)	Percentage of fat in fish of different fat degrees.
1	up to 250	up to 0·5
2	250-400	0·5-0·9
3	400-550	0·9-1·3
4	550-700	1·3-1·7
5	700-850	1·7-2·1
6	850-1000	2·1-2·5
7	1000-1150	2·5-2·9
8	1150-1300 or above.	2·9-3·5

Grouping of Trichiurus

Primary grouping in the case of the ribbon fish was done with reference to the scale of maturity. This was a reversal of the principle followed in regard to *Dussumieria* and *Pellona* (Sekharan, 1949 and 1950), which were first classified according to size and fat variations studied in relation to the period of the year, food and maturity. For the ribbon fish two broad groups were recognised, viz., immature and maturing. The immature group consisted of fish whose gonads were in stages I and II; those in stage II and above were included in the maturing group. It may be of interest to add here that the commercial catches did not contain specimens in stage VI (spawning). The samples collected during the period of the study totalled 468 individuals. Table 2 gives the numerical strength of the two groups in different months.

TABLE 2

The number of immature and maturing *Trichiurus* obtained in different months.

Month	Immature	Maturing
August	52	—
September	25	8
October	42	15
November	27	18
December	19	39
January	11	29
February	10	17
March	15	15
April	56	13
May	24	12
June	21	—
Total	302	166

The Immature Trichiurus

Altogether 312 fish in stages I and II were examined from August 1948 to June 1950 and they ranged between 20 cm. and 60 cm. in length. The immature fish formed the bulk of the catches during the months August to November, and the larger ones among them, especially those measuring 50 cm. and above, consisted mostly of recovering spents whose gonads had reverted to stage II before ripening again. After November, there is a distinct fall in the abundance of the immature *Trichiurus* in the inshore waters, apparently because the bigger sizes among them pass over into the maturing group from this time onwards. However, from April to June the percentage of fish in stages I and II rises again. This is to be attributed both to the recruitment of very young specimens into the fishery and to the gradual disappearance of the maturing group from the coastal waters.

The monthly fat values of the immature stock are represented in fig. 2 and table 3. As there was no significant variation between the two years with regard to the periodic trends of fatness, the figures for corresponding months are combined. So also, the sexes did not differ much in their fat content, and therefore they were not treated separately.

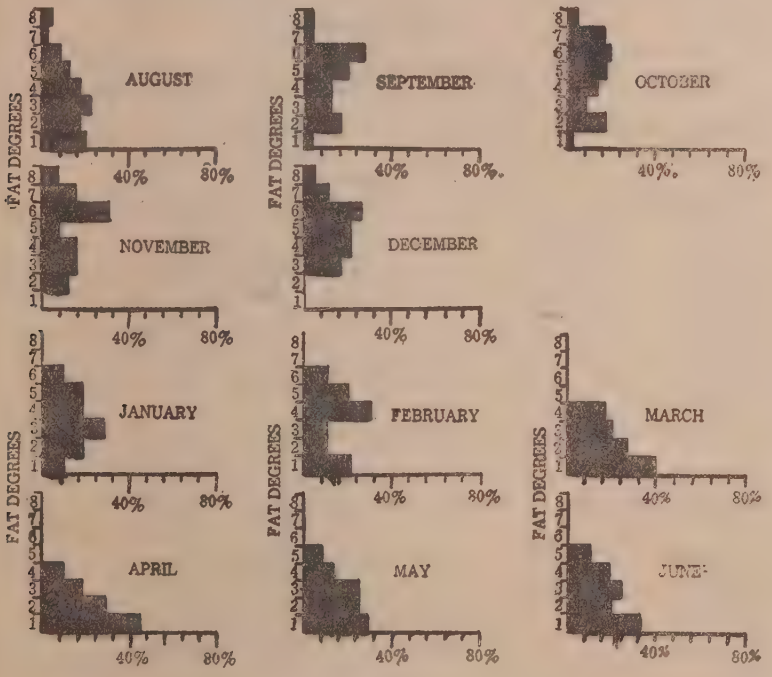

Fig. 2.

The fat value of immature *Trichiurus* in different months. (In terms of percentage number in each fat degree.)

In August about 20% of the fish were in fat degree 1 and 25% were in degree 5 and above. The comparable figures for October were 2% and 57% respectively, which indicates a rapid improvement in the quality of the ribbon fish. Of the immature fish of November, there were none in degree 1 and in December those in degrees 5 and above constituted about 63% of the sample. It was also noticed that fat degrees 1 and 2 were unrepresented during this month. These lower degrees of fatness reappear in about 27% of the fish included in the January sample, another striking feature of which was the absence of degrees 7 and 8. It will be apparent

from this that in January the immature fish suffered a drop in fat value compared to their condition in December. This decline continued during the succeeding months as well, and in April as much as 45% were in degree 1 and there were no specimens in degrees above 4. A slight recovery is indicated for the months of May and June.

TABLE 3

The fat value of immature *Trichiurus* in different months.

Months	Fat Degrees								Average
	1	2	3	4	5	6	7	8	
August	10	9	11	9	6	4	1	2	3·3
September	1	4	3	3	5	7	1	1	4·5
October	1	7	4	6	7	8	7	2	4·7
November	—	3	4	4	2	8	4	2	5·0
December	—	—	3	4	4	5	2	1	5·1
January	1	2	3	2	2	1	—	—	4·4
February	2	1	1	3	2	1	—	—	3·5
March	6	4	3	2	—	—	—	—	2·1
April	25	16	10	5	—	—	—	—	1·9
May	7	6	6	3	2	—	—	—	2·5
June	6	4	5	4	2	—	—	—	2·6

The mean monthly fat degrees of the fish are given in table 3. They also show that the immature stock were fattest in the months November and December and leanest in April.

Fat content of immature Trichiurus in relation to length

As mentioned before, the immature stock available in the inshore waters embraced a wide range of size. In order to ascertain whether fat content varied, to any extent, with length, the fish were arbitrarily divided into four size-groups, viz., 20-29 cm., 30-39 cm.,

40-49 cm. and 50-59 cm. The average fat degrees of the various length-groups during different months are indicated in table 4.

TABLE 4

The relation of length to fatness in immature *Trichiurus* (the number of fish in each length group is given within brackets)

Months	Length groups			
	20-29 cm.	30-39 cm.	40-49 c.m.	50-59 cm.
August	1·8 (15)	3·2 (5)	3·8 (24)	5·1 (8)
September	2·0 (1)	3·6 (8)	4·9 (7)	5·2 (9)
October		4·2 (21)	5·1 (20)	5·0 (1)
November		4·4 (7)	5·3 (20)	
December		4·9 (15)	6·0 (4)	
January		4·1 (9)	5·5 (2)	
February		3·5 (10)		
March		2·1 (15)		
April	1·9 (41)	2·0 (15)		
May	2·2 (9)	2·6 (15)		
June	2·1 (8)	2·9 (13)		
Average fat degree	1·9	3·4	4·8	5·2

It will be evident that among *Trichiurus* of maturity stages I and II, the larger ones are consistently fatter. But the data also show that there are periodic variations in the size-composition of the immature group. Hence, when the larger, fatter fish ripen their gonads and enter the maturing group, or when there is a recruitment of smaller sizes into the fishery, the average fat value of the immature stock as a whole would fall. With a view to investigating this aspect still further, the average length of the samples

examined in different months were calculated and compared with the fat value of the stock. (See fig. 3).

The mean size of the fish is more than 40 cm. during the months August to November, and it reaches the minimum in April. In May and June there is another rise in average length. This might to some extent explain the observed fluctuations in fat content of the immature stock. However, this relation is not always apparent and some of the discrepancies may be drawn attention to here. Thus, though the highest level of fatness was noted in December, the mean size of the fish of that month was considerably lower than

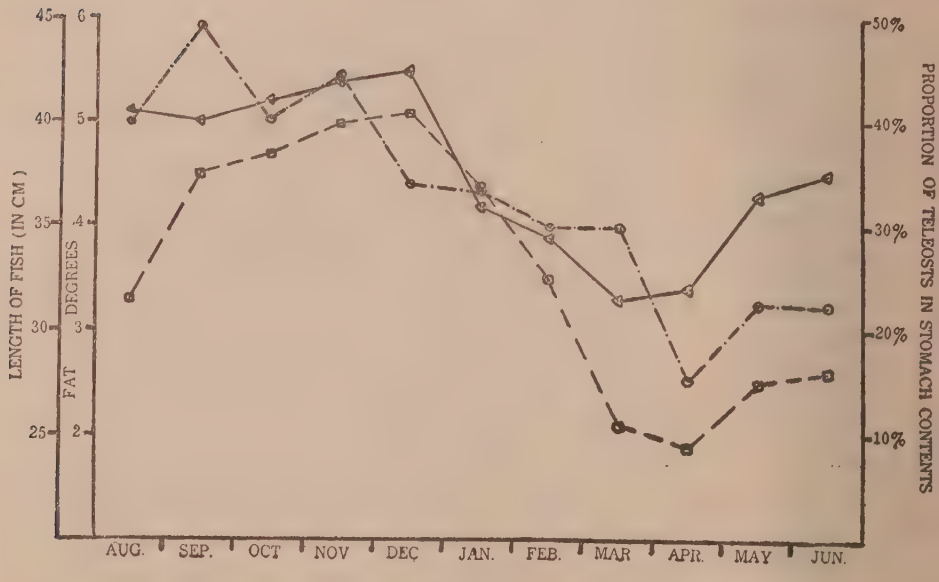

Fig. 3.

Average fat degree (— — —), mean length (— · — · —) and food (teleosts) (———) in immature *Trichiurus*.

that recorded during November. Similarly, both the February and March samples had the same average length, yet the March fish were much leaner than those of February. These instances point to the likelihood of the fat cycle being influenced by other factors as well, of which food is perhaps the most important.

Food and Fatness in Immature Trichiurus

The results of analyses of the stomach contents are summarised in table 5.

TABLE 5

Average volume of stomach contents and percentages of the chief items of food consumed by immature *Trichiurus* in different months.

Months	Average volume of stomach contents (in cc.)	Teleosts	Crustacea	The rest including digested matter
August	3·2	41%	17%	42%
September	4·2	40%	12%	48%
October	5·0	42%	11%	47%
November	6·4	44%	4%	52%
December	6·8	45%	5%	50%
January	3·8	32%	16%	52%
February	2·5	29%	20%	51%
March	2·0	23%	22%	55%
April	1·5	24%	25%	51%
May	1·8	33%	22%	55%
June	1·9	35%	8%	57%

The fish appear to feed intensely during the period August-December, if the average volume of the items recorded from the stomach is an indication. Crustacea are taken only in small numbers, teleosts being the main item. This is the period of a rapid build-up of fats in the tissues which reaches its peak in November and December. During the months January to April there is a marked fall in the quantity of food taken. The drop in volume noted in January might, of course, be the partial result of the exclusion of the larger size-groups form the immature stock. But the same argument does not apply to the changes that occur in the succeeding months, which are probably caused by a real decline in the availability of food. It may be seen that crustacean items gain added importance during the January-April season. At the same time the teleostean constituents of the diet decrease steadily. The loss in fat value is probably related to these changes in food. In May and June there is an improvement both in the average

volume of food and the quantity of teleosts consumed, which coincides with an increase in the fat content of the muscles.

Maturing Trichiurus

Maturing fish (those in stage and above) are always relatively large, measuring not more than 40 cm. in length. They shoal in the inshore waters from September to January, gradually forsaking

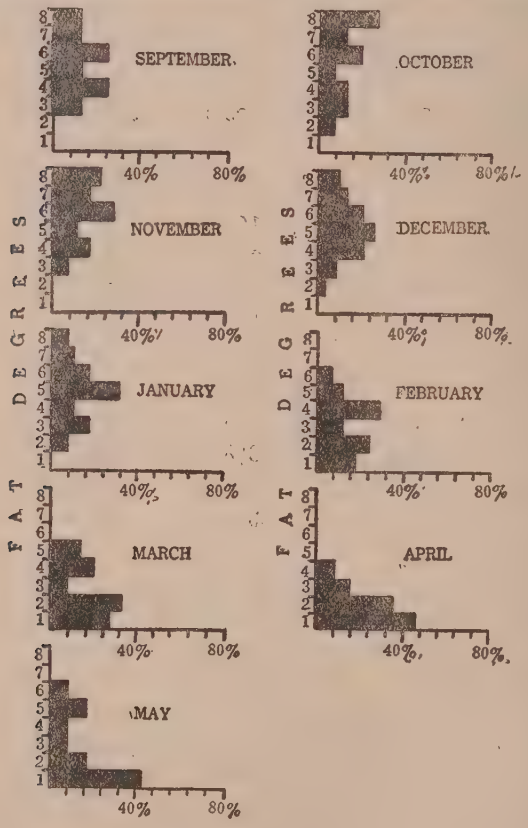

Fig. 4.

The fat value of maturing *Trichiurus* in different months (in terms of percentage number in each fat degree).

the area in later months. The June and July catches contain practically no ribbon fish of this category. The data presented in table 7 give a probable explanation for this. After February, the maturing fish belong to stages above III; also, the observed weight of the

gonads registers its peak in April and May. Spawning should therefore take place either in these months or in the immediately succeeding months. When to this is added the fact that specimens in stage VI have not been recorded from the catches, the conclusion seems evident that in May, June and July, fish with ripening gonads migrate to offshore waters, probably for spawning.

According to Prabhu (1955) *Trichiurus* is an offshore spawner. He also states that the fish breed in June.

The monthly fat degrees of the maturing fish are shown in fig. 4 and table 6. As before, the figures for the sexes as well as the corresponding months of the two years are combined. Of the fish collected during September, about 50% ranged between fat degrees 6 and 8, and altogether 67% were above degree 3. The maximum fatness was recorded in November when about 67% were in degrees 6 to 8 and no specimens were seen in degrees 1 and 2. From December onwards, the number of fish in the lower fat degrees rises and the condition of the April fish when about 77% were in degrees 1 and 2 presented a complete contrast to what was witnessed in November.

TABLE 6

The fat value of the maturing *Trichiurus* in different months.

Months	Fat Degrees								Average
	1	2	3	4	5	6	7	8	
September	—	—	1	2	1	2	1	1	5·4
October	—	1	2	2	1	3	2	4	5·6
November	—	—	1	3	2	5	3	4	6·0
December	—	1	3	8	10	8	5	4	5·3
January	—	2	5	3	9	5	3	2	4·9
February	3	4	2	5	2	1	—	—	3·1
March	4	5	1	3	2	—	—	—	2·6
April	6	4	2	1	—	—	—	—	1·8
May	5	2	1	1	2	1	—	—	2·7

When the monthly mean fat degrees were calculated they gave the same general picture as described above. November showed the highest average and April the smallest. In May only 12 specimens could be collected and the mean fat value for that month was greater than that noted for April. Taking into consideration the smallness of the sample, the increase is possibly not significant. However, the probability that it portrays a real upward trend cannot be discounted, especially since the immature stock also exhibits a similar phenomenon at this time.

Fatness and length of maturing fish

The maturing fish could conveniently be divided only into two size-groups, viz., 40-49 cm., and 50-59 cm. Their average fat values are given in table 7.

TABLE 7

The relation of length to fatness in maturing *Trichiurus*. (The number of fish in each length group is given within brackets)

Months	Length groups	
	40-49 cm.	50-59 cm.
September	5·2 (5)	5·7 (3)
October	5·3 (4)	5·8 (11)
November	5·9 (7)	6·1 (11)
December	5·3 (20)	5·5 (19)
January	4·9 (24)	5·2 (5)
February	3·2 (9)	3·0 (8)
March	2·4 (9)	2·6 (6)
April	2·0 (8)	1·6 (5)
May	2·8 (11)	1·0 (1)

Broadly speaking, the larger fish seem to be slightly richer in muscle fats during the period September to January than the smaller ones. It is, however, important to note that there is no well-marked disparity between the two groups in this respect. Barring May, when only one specimen was examined in the 50-59

cm. group, the maximum value of the difference amounted only to 0·5 fat degree and it occurred in the months of September and October. During the other months it ranged between 0·2 and 0·4 fat degree, which is perhaps well within the experimental error inherent in the methods employed. It may therefore be surmised that changes in size-composition would be of little consequence as far as the fat value of the maturing group is concerned—a condition remarkably different from that of the immature stock.

The average lengths of the monthly samples are plotted in fig. 5. The October sample had the maximum mean size, but the peak value for fatness was recorded in November. Again, the mean size was practically the same in the months of March and April,

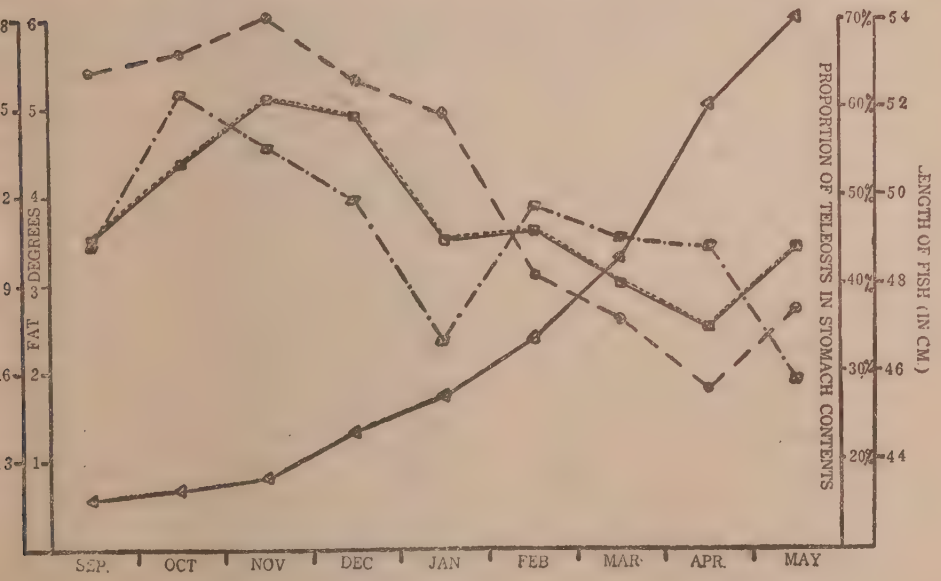

Fig. 5.

Average fat degree (— — —), mean length (— · — · —), food teleosts) (·····) and average weight of the gonads (———) in maturing *Trichiurus*.

while in February it was greater than that shown for January; and yet, the fish become progressively leaner from January onwards. Apparently, the fat cycle has to be explained in terms of other factors. Of the latter, two most obvious ones, viz., food and maturity are considered here.

Food of maturing fish in relation to fat content

The maturing fish seem to maintain a uniformly high rate of feeding from October to December. Teleosts which form the staple diet are abundant at this time and the stomach always revealed a large number of fish belonging to various families. Sometimes they even formed 80-90% of the contents.

TABLE 8

The average volume of stomach contents and the percentages of the chief items of food consumed by maturing *Trichiurus in different months.*

Months	Average volume of food taken (in cc.)	Teleosts	Crustacea	The rest including digested matter
September	5·6	45%	5%	50%
October	6·4	54%	3%	43%
November	7·5	61%	5%	34%
December	7·1	59%	6%	35%
January	6·2	45%	10%	45%
February	5·5	46%	8%	46%
March	4·9	40%	11%	49%
April	4·2	35%	13%	52%
May	5·2	44%	11%	45%

Crustaceans are taken only irregularly and that too only in small quantities. The intensity of feeding and the abundance of teleostean items probably contribute to a great increase in fat deposition which reaches its peak in November. In December feeding does not change appreciably either in quality or in quantity, but the fat content or the muscles shows a downward trend. But from January onwards the proportion of teleosts found in the stomach drops, and the fish on the whole takes in less volume of food. Crustacea continue to be a numerically important item of the diet, but apparently are not fattening enough, and in April when the ribbon fish is poorest in average fatness teleostean items decline to their minimum value.

Maturation in relation to fatness

In December, the intensity of feeding is almost the same as before, especially as far as it applies to teleostean constituents; still a lowering of fat value is noticed. Probably this is the result of the fat expenditure necessitated by the growth of gonads (see fig. 5). From September to November the fish are in stage III and they are very rich in fat because the loss, if any, from the muscles during the transition from stage II to stage III would be small and could perhaps be more than compensated for by the intensity of feeding. Besides, it is possible that the fat required for the development of the gonads came from the liver and other visceral organs which have not been considered here.

The average weight of the gonads and the number of fish in different maturity stages are shown in table 9. (In the table the weights of both testis and ovary are combined to get the average).

TABLE 9

The stages of maturity and the average weight of gonads *of Trichiurus in different months*

Months	Maturity stages					Average weight of the gonads (in gms.)
	I	II	III	IV	V	
September	—	—	8	—	—	0·17
October	—	—	15	—	—	0·20
November	—	—	18	—	—	0·25
December	—	—	35	4	—	0·40
January	—	—	6	20	3	0·52
February	—	—	2	9	6	0·71
March	—	—	—	8	7	0·98
April	—	—	—	3	10	1·50
May	—	—	—	—	12	1·80

The gonads have an average weight of about 0·25 gm. in November, and it goes up to about 0·40 gm. in December when some of the fish enter maturity stage IV. These changes probably result in the

withdrawal of muscle fats which the fish is unable to replace in spite of vigorous feeding. During January the number of fish in stage IV increases and stage V is also touched, and by April the majority are in stages IV and V. Progression of maturity is accompanied by a rather rapid increase in the weight of the gonads and it coincides with the depletion of fat reserves. Fats are probably not deposited in the ova after stage V, and the month of May when stage V is the dominant maturity scale, registers a slight increase in the muscle fats of the stock.

Discussion

From a comparison of the results summarised in tables 3 and 6 it will be evident that maturing *Trichiurus* are on the whole fatter than the immature ones. The two groups also vary with reference to their diet,the former taking in more of teleosts and less of crustacea than the latter. But this could perhaps be regarded as partially incidental to the difference in their average lengths. This aspect, namely the relation between food and length in the ribbon fish has been investigated by Vijayaraghavan (1951). He divides the population into two categories according to size, and finds that the menu of the bigger fish includes a greater proportion of teleosts and less of crustacea than that of the smaller ones. According to Prabhu (1955) *Trichiurus haumela* is a selective feeder. He also observes that fish of 46-62 cm. feed on fewer prawns and smaller fish than the younger ones. A further dissection of his data shows that the teleosts taken by fish less than 39cm. consist of *Anchoviella* spp., *Dussumieria* spp., *Leiognathus* spp. and rarely of *Therapon* spp. and *Caranx* spp; but a wider range of species belonging to various families is preyed upon by the larger individuals. The maturing *Trichiurus*, as has already been explained, have a size-range of 40-59 cm., while the immature fish vary from 20 to 59 cm; however, within the latter group, specimens measuring more than 40 cm. are rarely met with during the January-July season. Since growth in length ensures a greater swimming power and a capacity to handle a larger size-range and variety of prey, the maturing fish, by virtue of their greater mean size, have an obvious advantage over the immature stock, and their greater fatness should be attributed, at least partly, to their habit of consuming more teleosts than the latter—an instance parallel to what was found in the case of *D. acuta* and *P. hoevenii* (Sekharan 1949 and 1950). The possibility of fishes exercising selection is not discounted here, but when it occurs, especially in a carnivore like *Trichiurus*, it would undoubt-

edly be influenced to some extent by the size or prey that a particular length group can avail of.

However, it is possible to visualise a length beyond which food consumed would not vary significantly, at least to the same extent as in lower size-grades. Above this limit, fatness, as far as it is governed by diet, also would not vary materially in relation to length. For *Trichiurus*, this limit appears to lie somewhere between 45 cm. and 55 cm., since as has been indicated earlier, there is little to choose between the relative fatness of the two size-groups, 40-49 cm. and 50-59 cm., that constitute the maturing part of the population. On the other hand, within the immature group fat content increases steadily with rise in length, i.e., from the 20-29 cm. group to 40-49 cm. group. Returning again to Prabhu's data, it is seen that above the 47-49 cm. size-grade, there is practically little change in food.

Excepting probably for Channon and Saby (1932) who do not believe that age has any bearing on the fat content of herring, most other workers have demonstrated a positive correlation between the two factors in fishes that they studied. Thus Bruce (1924) states that the fat value of herring is increased by age independent of maturity, and according to Lovern (1938), that of the eel rises "almost linearly with length, at least within certain limits." In immature flounder, Wilson (1939) found that "a size increase brings about a slight general fattening, as measured histologically"; but in the mature flounder, there was little tendency to enhanced fat content with size. Chidambaram *et al* (1952) pointed out that in the Indian mackerel, there is a greater accumulation of fat as the fish grows in length. However, an entirely different view is held by Hickling (1947); he shows pilchards become poorer in fat value when they pass beyond the size of 20 cm. What is interesting is that in almost all cases investigated so far there is a limit in length above which the fishes vary very little in fat content or become even leaner.

Both the immature and maturing *Trichiurus* are leanest in April; the maximum values for fatness are recorded in the months of November and December. More or less corresponding changes are also witnessed in the food cycle of both groups. In this context, the period January to April deserves special mention. During these months, the teleostean constituents of the diet of the fish register a steep drop, and this coincides with a fall in the average volume of the stomach contents. Crustecean items attain greater prominence

at this time than they did during the preceding period, but still the fish become steadily leaner. This again seems to emphasise the importance of teleosts in the nutrition of the ribbon fish. It may be mentioned here that the observations made during this study on the feeding cycle of the fish find corroboration in their broad outlines, in the investigations reported on by Vijayaraghavan (1951) and Prabhu (1955). The former says that there is a definite increase in the volume of the stomach contents from September to December, and in the data given by the latter the peak figure for the volume of stomach contents is noted against the month of December.

The relation between fatness and the quality and quantity of food has formed the subject of many other studies on fishes. (Channon and Saby 1932, Lovern and Wood 1937, Dixon 1937, Wilson 1939, Hickling 1947 etc.). A correlation between fat content of plankton and that of herring has been established by Wimpenny (1938). Dealing with the red mullet, *Upeneus indicus* Ramaswamy (1955) has also dwelt on the influence on the fat value of food on that of the fish. According to Chidambaram *et al* (1952), there are two peaks of fat accumulation in an year for the Indian mackerel, and they attribute this to feeding activity. They have also shown that periodic variations occur in the size-composition of the commercial catches of mackerel. In *Trichiurus* changes in size affect the monthly fat values of the immature group, but are of little significance as far as the other group is concerned.

The evidence advanced for proving the influence of maturity on the fat content of the fish is of course rather indirect. The problem here is complicated by the fact that the ripening of the gonads and the decline in fat value occur simultaneously with a fall in the quality and quantity of food. However, it is seen that the maturing groups experiences a greater loss of fat than the immature stock during the January-April period. They have much the same fat value in April, though, when in peak condition, they differ markedly. The greater extent of fat depletion suffered by the maturing stock could perhaps be ascribed to an increase in metabolic requirements occasioned by the rapid development of the gonads. Hickling (1947) also recognises the effect of the ripening of the testes and ovary on the fat content of the pilchard. Most other workers, however believe that there is little, if any, pre-spawning depletion, and that a rapid exhaustion of muscle fats occurs after spawning. With the available data, it is difficult to say whether spawning has any effect on the fat content of the ribbon fish. But it must be

emphasised here that most of the fishes where such a phenomenon has been demonstrated are known to abstain from food during the spawning period.

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Further Studies on Dyke Rocks of Pallavaram

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ABSTRACT.

The structural, petrographical and petrochemical characteristics of the dykes of Pallavaram are described in this paper. Following the petrochemical methods of Niggli the author is driven to the conclusion that these dykes belong to Pacific suite and their parent magma is Eucrite. As the dykes show interaction along the contact zones, the possibility of contamination of magma in giving rise to tholeiitic types is not altogether ruled out.

Introduction.

An earlier paper on the dyke rocks of Pallavaram was published by the author (1954) in this journal. Since then dykes of diverse composition displaying discordant relation (Plate 1. Fig. 1.) to the charnockitic complex have been noticed in Pallavaram (Map, Fig. 1), the type area of charnockites of Sir Thomas Holland. They vary in length from one foot to one mile and the width ranges from a few inches to 200 feet. The trend of the major dykes swings from N. 60°.W—S. 60°.E to N. 80°.W—S. 80°.E and the strike of minor ones varies from N. 40°.E—S. 40°.W to N—S. Most of these dykes are vertical but in some places they dip at high angles and they are highly jointed. There are a few off-shoots of these dykes along the horizontal joint planes of the charnockites which dip 20° due North. Some of the dykes contain Xenoliths of acid charnockite (Plate. 1. Fig. 2) and show interaction along the contact zones as reported by the author (1955). The structural, Petrographical and Petrochemical characteristics of the dykes are presented in the following pages.

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OUTLINE STRUCTURAL MAP OF PALLAVARAM

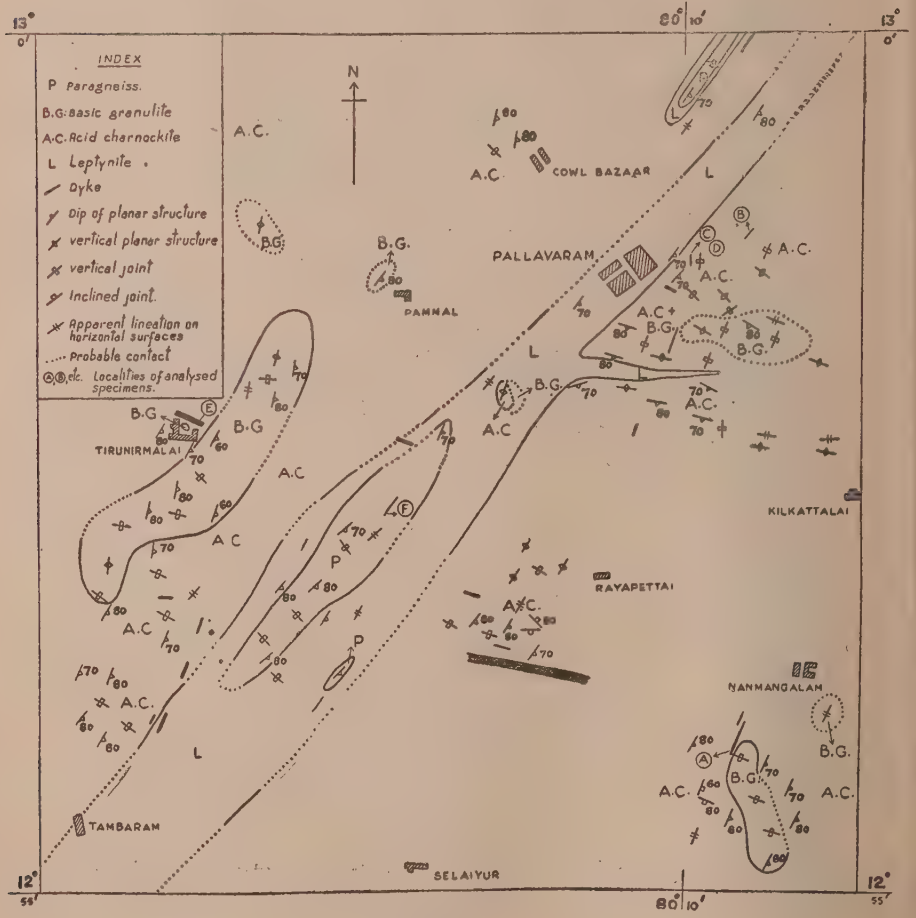

Fig. 1.

SCALE

FURLONGS 8 6 4 2 0 1 MILE

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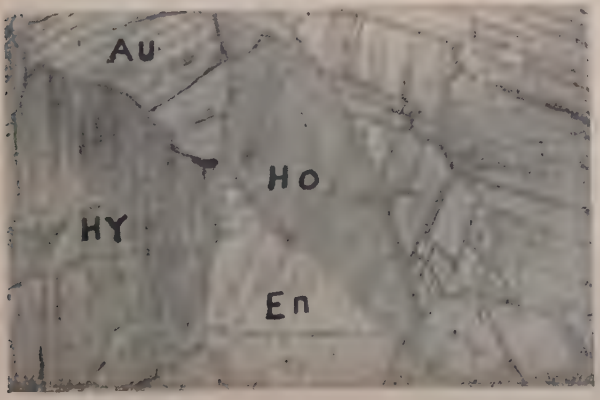

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Structural Control of Intrusion

Structural control of the intrusion of dykes can be best understood by the study of structural features of the country rocks which comprise paragneisses, charnockites and leptynites. Fig. 1. is the outline structural map of Pallavaram showing the major joint and foliation planes of the country rocks and their major contacts together with the contacts of dykes. The steeply dipping joints,

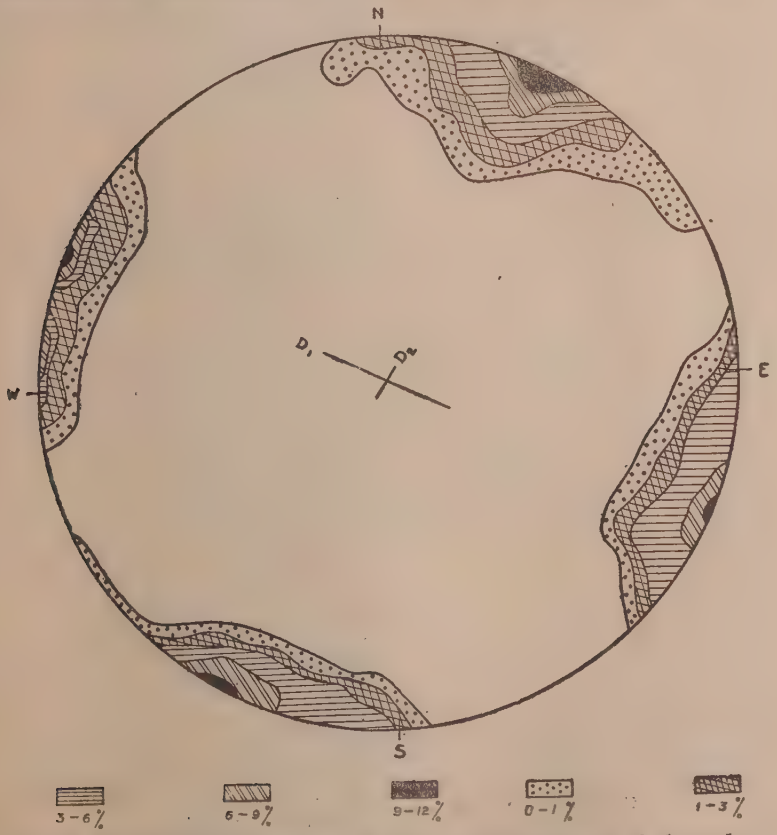


Fig. 2. Stereographic projection on the lower hemisphere of the poles of 230 Joint planes of Charnockites and associated rocks. Contour intervals in percent: 0-1-3-6-9-12. The trends of the dykes D_1 D_2 are superimposed on the projection.

excluding minor variations, form a regular pattern which is consistent over the whole area. One set of major joints is parallel or nearly parallel to the foliation planes and the other set is either

perpendicular or inclined at varying angles to the foliation planes of the country rocks.

Fig. 2, is a projection of the poles of 230 joints measured without selection and the major contacts of the dykes are super-posed on the same projection. There is a remarkable coincidence of the major joint directions and the trend of the contacts of the dykes with the country rocks. This leads to the conclusion that the contacts of the dykes were controlled by an early formed master joint-systems in the country rocks. Indeed, this seems to be the only explanation for the steep and straight disposition of contact surfaces of these dykes which do not display shattering, shearing or displacement of the wall rocks.

Petrography

The components of the dykes of Pallavaram are pyroxenite, olivine dolerite, phaneritic and aphanitic dolerites, enstatite-augite-diorite and micropegmatite.

Pyroxenite reported by Sir Thomas Holland (1897) to occur intrusive into the charnockites of Pallavaram is a coarse grained greenish black rock characterized by a hypidiomorphic texture (Plate 1, Fig. 3). It is principally constituted of enstatite, hypersthene, augite and hornblende. Enstatite is colourless and occurs as subhedral and anhedral plates measuring up to 0·80 mm. in length. 2V = +88°; +84°; −86°; −82°. Some plates show (100) twinning lamellae. Hypersthene occurs as subhedral crystals and is pleochroic, X = tinge of pink, Y = colourless, Z = pale green. −2V (variable) = 60°; 62½°; 67½°; 72° (Enstatitic). Augite is colourless and anhedral. + 2V (variable) = 52°; 48° (common), 40°. Z Λ C = 44° (by projection) with reference to prismatic cleavage. Hornblende occurs as an alteration product of pyroxenes and is pleochroic, X = yellowish green, Y = green, Z = bluish green. −2V = 72° and Z Λ C = 16° (by projection) with reference to prismatic cleavage. A reddish brown non-pleochroic biotite is present associated with the grains of iron ore.

Olivine dolerite is a medium grained dark grey non-porphyritic dolerite. In thin sections it is remarkably fresh and the plagioclase felspars occur in typical sub-ophitic relation to the clinopyroxene. Plagioclase is lath shaped, mostly less than 0·4 mm. across and rarely reaching 1 mm. in length. Twinning after albite-carlsbad and carlsbad laws are common. Some laths show indistinct zoning. The anorthite content ranges from 50-80 percent.

Olivine occurs as euhedral and subhedral grains (Plate 2, Fig. 1) and is pleochroic, X = brownish green, Y = pinkish brown, Z = Pink. $+2V = 86°$ (Forsteritic). One set of cleavages parallel to (010) is present. Enstatite occuring by the side of olivine grains is colourless and shows one set of prismatic cleavages. Augite is the abundant pyroxene. +2V (variable) = 40°; 43°; 48°; 52°. $Z \Lambda C = 43°$ measured on (100) twinned grains. Magnetite occurs as an accessory ingredient.

Phaneritic dolerite is a medium grained greyish black rock. It displays sub-ophitic texture (Plate, 2, Fig. 2) under the microscope and the constituent minerals are plagioclase, enstatite, augite and pigeonite. Plagioclase laths are invariably twinned and out of the 20 grains determined 9 were albite-carlsbad and 11 were carlsbad. Some grains display weak zoning. The range of anorthite content is from 55-65 percent. Enstatite occurs as subhedral colourless plates with one set of prismatic cleavages. Augite is the most abundant pyroxene and it occurs both as a rim around enstatite and as individual plates. It is colorless. +2V (variable) = 38°; 40°; 48°; 52°. $Z\Lambda C = 42°$ measured on (100) twinned grains. Pigeonite occurs as patches in the augite plates and as individual grains. +2V (variable) = 16°; 17½°; 25°; 30° in the plane perpendicular to (010). Some grains are uniaxial. Sometimes it shows zoning. +2V of the core is 16° and of the periphery 40°. $Z \Lambda C = 39°$ with reference to prismatic cleavages. Hornblende and biotite occur as alteration products of pyroxenes and magnetite as an accessory.

Aphanitic dolerites of Pallavaram are fine-grained greyish black rocks and based on their texture under the microscope they can be classified as *sub-ophitic, Vitrophyric* and *Pilotaxitic* types.

Aphanitic sub-ophitic dolerite is composed of plagioclase and pyroxene together with magnetite. Plagioclase which is the most abundant mineral shows clouding and twinning on albite-carlsbad and carlsbad laws. The anorthite content ranges from 48 to 55 per cent. The felspar laths project into augite prisms and impart to the rock a sub-ophitic texture. Pyroxene occuring in this rock is augite and it shows alteration to hornblende and chlorite along the periphery. Magnetite occurs as a released mineral and apatite is an accessory ingredient.

The vitrophyric variety is a compact dark grey rock mainly composed of glomeroporphyritic groups of plagioclase and pyro-

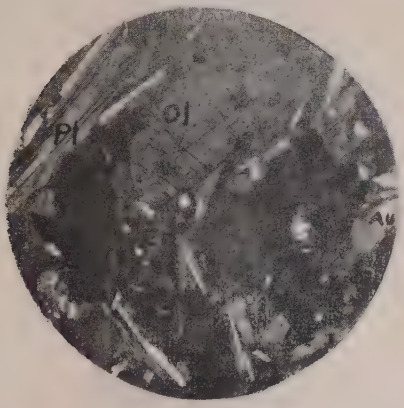
xene embedded in a fine grained matrix (Plate 2, Fig. 3) under the microscope. The occurrence of plagioclase as idiomorphic prisms suggests its early formation. The average anorthite content is 55 per cent and some of the laths exhibit zoning. The common twinning is on albite-carlsbad and carlsbad laws. A few euhedral and subhedral phenocrysts of pyroxene suggest that they have crystallized immediately along with the plagioclase. The phenocrysts are augite and the groundmass contains both augite and pigeonite. The fine-grained matrix under high power is seen to be made up of an aggregate of plagioclase, pyroxene and magnetite. In one section brown palagonite developing at the expense of augite and magnetite is seen and there is also green palagonite which is isotropic in character.

The pilotaxitic type is similar to the vitrophyric variety in essential mineralogical characters, but there is the absence of a dense fine-grained matrix. The ground mass is made up of a plexus of minute felspar laths (Plate 2, Fig. 4) with which are mingled augite and magnetite.

Enstatite-Augite-diorite is a medium grained greyish black rock characterised by an indistinct sub-ophitic texture under the microscope (Plate 2, Fig. 5). Plagioclase felspars (Ab_{65} An_{35} to Ab_{47} An_{53}) exhibit twinning on two common laws, albite-carlsbad and carlsbad, and are clouded. Orthoclase is sparingly present in the micropegmatite portion. The principal mafic minerals are enstatite, augite and pigeonite. Augite borders are sometimes characterised by hornblende. Quartz occurring in the micropegmatite portion exhibits myrmekitic intergrowth with plagioclase. Biotite is a secondary mineral and apatite and magnetite occur as accessories.

Micropegmatite is a bluish grey rock exhibiting a typical micropegmatitic texture (Plate 2, Fig. 6) under the microscope due to the intimate intergrowth of quartz and microcline. The plagioclase felspars (Ab_{68} An_{32} to Ab_{73} An_{27}) show clouding. Myrmekite occurs at the contacts of potash and soda felspars. Flakes of biotite occurs associated with shreds of augite and hornblende which occur in subordinate amounts. Magnetite occurs as a released mineral.

Modes of the pyroxenite, olivine dolerite, phaneritic dolerite, aphanitic sub-ophitic dolerite and enstatite-augite-diorite are shown in Table 1.



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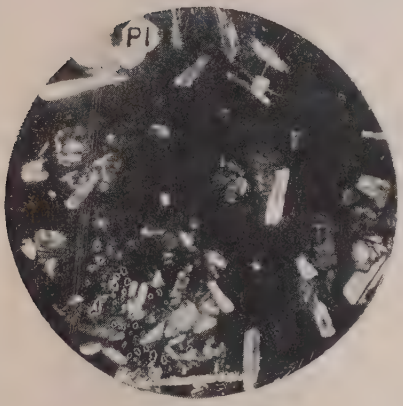

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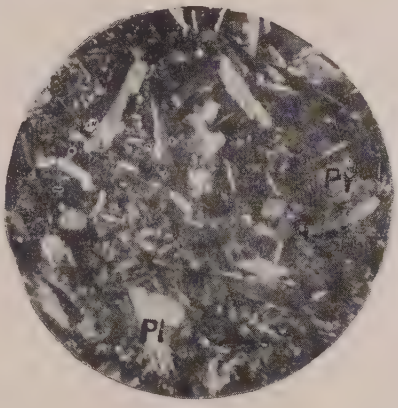

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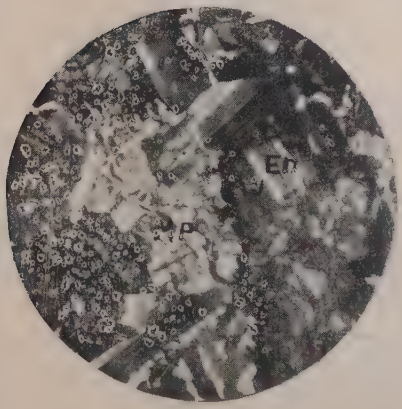

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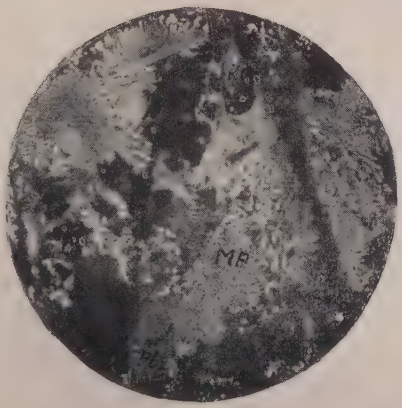

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MODES OF DYKE ROCKS OF PALLAVARAM

TABLE I

Pyroxenite.		Olivine Dolerite		Phaneritic Dolerite		Aphanitic Sub-Ophitic Dolerite		Enstatite-Augite-Diorite.	
Hypersthene	— 30·0	Plagioclase	— 51·5	Plagioclase	— 51·5	Plagioclase	— 52·5	Plagioclase	— 44·5
Enstatite and Augite	— 39·5	Olivine	— 13·5	Augite, Pigeonite and Entite	— 42·5	Augite	— 44·0	Micropegmatite	— 9·5
Hornblende	— 26·0	Augite and Enstatite	— 31·0	Hornblende	— 1·5	Hornblende	— 0·5	Augite and Enstatite	— 39·0
Iron Ore	— 4·5	Iron Ore	— 4·0	Biotite	— 1·0	Magnetite	— 3·0	Hornblende	— 3·5
				Iron Ore	— 3·5			Biotite	— 1·5
								Iron ore	— 2·0

Petrochemistry

Fresh specimens of the components of the dykes were chemically analysed and their weight percentages together with their corresponding Niggli base molecular values are presented in Table II.

TABLE II

Weight percent and molecular base values according to Niggli of analysed rocks.

Constituents	A	B	C	D	E	F
SiO_2	46·28	47·42	48·21	50·15	54·96	71·80
Al_2O_3	8·32	16·10	14·60	13·80	13·15	13·24
Fe_2O_3	3·20	1·46	4·29	3·76	2·65	0·97
FeO	12·84	9·85	10·82	10·33	8·71	2·84
MnO	0·21	0·23	0·30	0·26	0·06	0·03
MgO	19·48	9·92	5·64	5·53	6·10	0·73
CaO	8·50	10·84	10·89	10·12	9·23	1·64
Na_2O	0·52	1·92	2·50	2·60	2·83	3·98
K_2O	0·14	0·34	0·28	0·57	1·74	3·86
TiO_2	0·29	1·40	1·23	1·52	0·56	0·21
P_2O_5	0·09	0·11	0·15	0·18	0·04	0·04
H_2O+	0·32		0·78	0·83		0·47
H_2O^-	0·07	0·55	0·32	0·37	0·11	0·32
Total	100·26	100·14	100·01	100·02	100·14	100·13

Molecular base values.

Constituents	A	B	C	D	E	F
Cp	0·1	0·1	0·1	0·1	—	—
Kp	0·3	1·0	1·0	2·1	6·1	13·9
Ne	2·6	10·4	13·8	14·5	15·3	22·1
Cal	11·9	20·7	17·3	15·0	11·0	3·9
Cs	6·6	5·8	8·2	8·0	8·3	0·5
Fo	40·2	20·8	12·2	11·9	12·7	1·5
Fa	15·0	11·7	13·3	12·7	10·3	3·3
Fs	3·3	1·5	4·7	4·2	2·9	1·0
Ru	0·2	1·0	0·9	1·1	0·4	0·2
Q	19·8	27·0	28·5	30·4	33·0	53·6
L	14·8	32·0	32·1	31·6	32·4	39·9
M	65·4	41·0	39·4	38·0	34·6	6·5
Q	19·8	27·0	28·5	30·4	33·0	53·6
π	0·80	0·65	0·54	0·47	0·34	0·10
γ	0·11	0·14	0·24	0·25	0·27	0·10
k	0·11	0·09	0·08	0·14	0·28	0·39
mg	0·69	0·61	0·40	0·42	0·49	0·26

A: Pyroxenite, Nanmangalam. Analyst: S. K. Babu.

B: Olivine Dolerite, Meenambakkam. Analyst: S. K. Babu.

C: Fine-grained Dolerite, Rifle Range. Analyst: N. Leelananda Rao.

D: Medium Grained Dolerite, Rifle Range. Analyst: N. Leelananda Rao.

E: Enstatite — Augite — Diorite, Thirunirmalai. Analyst: N. Leelananda Rao.

F: Micropegmatite, Pachaimalai. Analyst: N. Leelananda Rao.

Niggli molecular values of the dykes given below closely match with those of common magma types of the Pacific suite.

Comparison of dykes with magma types of Niggli.

	A	B	C	D	E	F
Si	72·0	100·0	110·0	120·0	138·0	360·0
al	8·5	20·0	19·6	19·4	19·4	38·8
fm	74·5	51·3	47·8	47·8	46·2	20·7
c	16·0	24·4	26·7	25·9	24·8	8·7
alk	1·0	4·3	5·9	6·9	9·6	31·8
ti	0·42	2·28	2·05	2·73	1·21	0·90
k	0·11	0·09	0·08	0·14	0·28	0·34
mg	0·69	0·61	0·40	0·42	0·49	0·26
Magma type	Hornblende peridotish	Eukritisch	Hawaiitisch	Hawaiitisch	Melagabbro Dioritisch	Rapakivitisch

The variation diagram (Fig. 3) drawn from the Niggli molecular values with si as abscissa and the other constituents as ordinate shows sharp rise and fall of the constituents with variation of si values. There are two sets of sympathetic curves. The alk curve is sympathetic to al and c to fm and these two sets show mutually opposing tendencies. The c curve rises steeply in the initial stages and then slowly falls, being sympathetic to fm. The isofalic point is 31 and the si value is 270. In this character the curves are those of extreme Pacific suite. The variation diagram resembles in general that of Lassen Peak given by Burri and Niggli (1945).

As the individual behaviour of soda and potash or of magnesia cannot be understood from the variation diagram (Fig. 3), the k-mg values of the dykes are plotted in the corresponding diagram

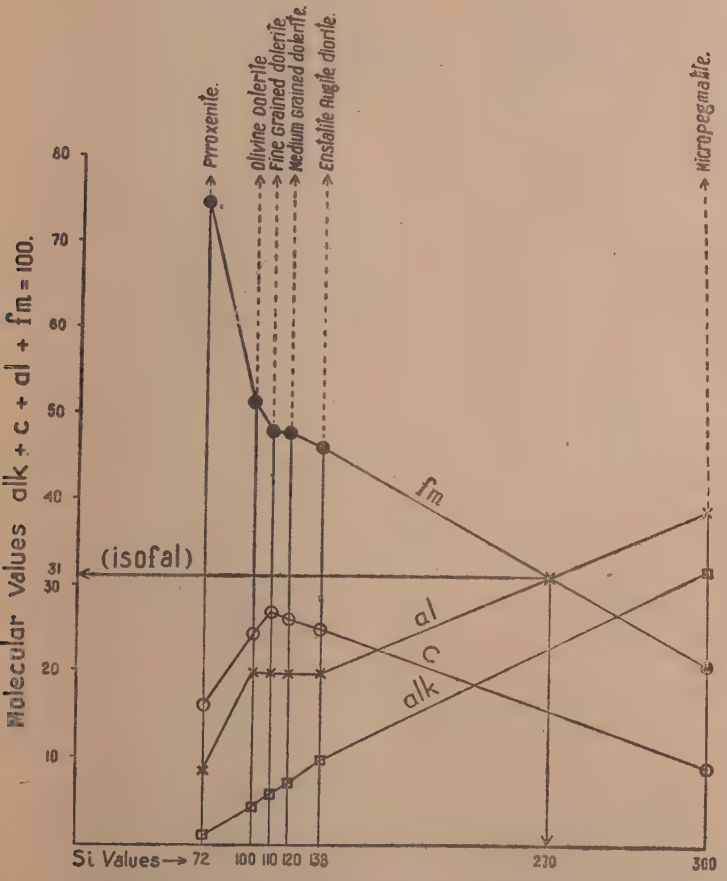

Fig. 3. Variation Diagram of the dyke rocks of Pallavaram. al = fm at 31, si = 270.

of the Lassen Peak (Fig. 4). From the diagram it is evident that the k-mg values of the dykes display a reciprocal relation to each other which is characteristic of the Pacific suite.

To understand the inter-relation of the three Niggli molecular base values Kp-Ne-Cal, k-π values of the dykes were calculated and plotted in the corresponding diagram of Lassen Peak

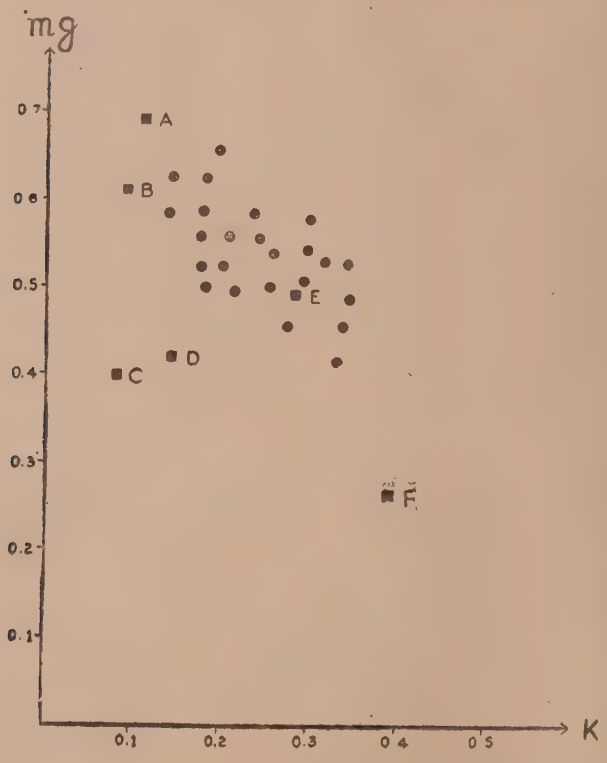

Fig. 4. mg-k diagram of Lassen Peak (after Niggli). Dyke rocks of Pallavaram. A = Pyroxenite. B = Olivine dolerite. C = Fine grained dolerite. D = Medium grained dolerite. E = Enstatite-Augite diorite. F = Micropegmatite.

(Fig. 5). Except for the dispersal of the point A there is close agreement between the plots of the dykes with that of the Lassen Peak and this clearly brings out the fact that dykes of Pallavaram belong to Pacific suite.

The same petroprovincial aspect of the dykes is revealed by the plots of the γ-mg values of the dykes in the corresponding diagram of the Lassen Peak (Fig. 6).

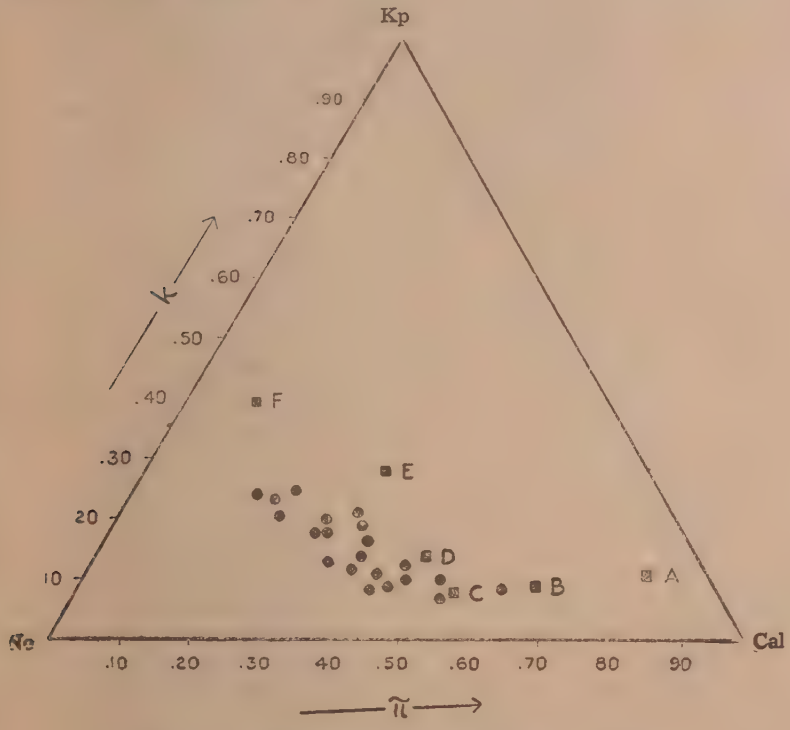

Fig. 5. k-π diagram of Lassen Peak (after Niggli)

= Dyke rocks of Pallavaram.

To gain an idea of the trends of differentiation of the magma which has given rise to these dykes belonging to Pacific suite, Normative mineral diagram of Niggli and Q-L-M diagram were prepared.

Fig. 7 is the Normative mineral diagram of Niggli which shows three distinct trends of differentiation:

(i) The enrichment in ferromagnesians with concomitant impoverishment in the total felspars resulting in type A.

(ii) The enrichment in alkali felspars with constant ferromagnesians giving rise to types C, D and E.

(iii) The enrichment in alkali felspars with constant anorthite content giving rise to type F.

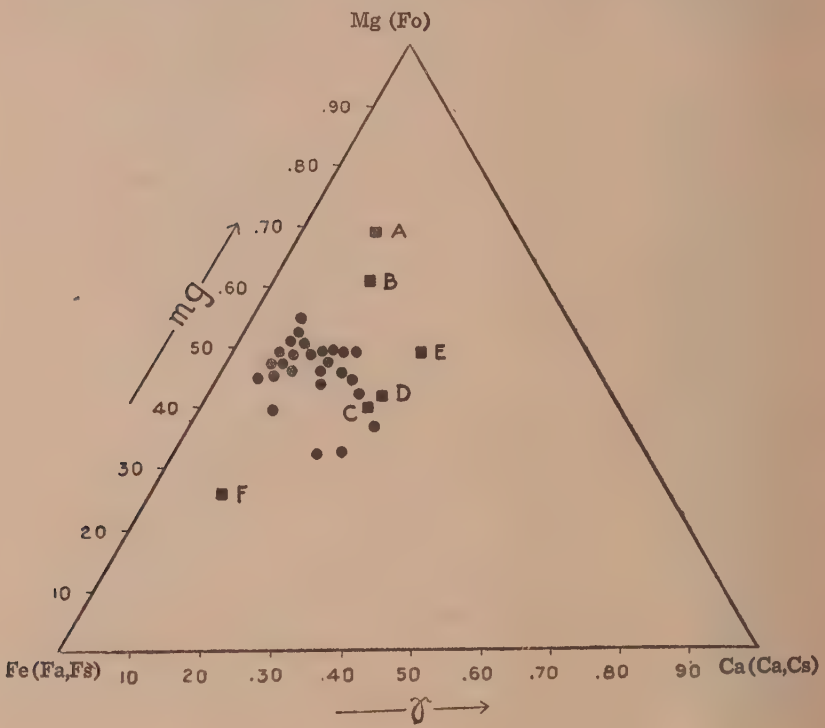

Fig. 6. mg-γ diagram of Lassen Peak (after Niggli).
■ = Dyke rocks of Pallavaram.

Fig. 8 is the Q-L-M diagram of the dykes of Pallavaram which gives us an idea of the trends of differentiation and the behaviour of quartz during the consolidation of the magma. From the figure it is evident that there are two distinct trends:

(i) B to A

(ii) B to F.

The trends of differentiation as revealed by the petrochemical studies of the dykes lead to the question of their parental magma. It is the popular conception amongst petrologists that all normal igneous rocks are derived from a basaltic magma whose Q-L-M values when plotted in the Triangular diagram fall within a small

region well below the line PF. In this region of normal basalts falls the rock type B (Eucrite) whose values agree closely with that of olivine basalt magma type. This leads us to a reasonable supposition that eucrite is the parent magma which owing to fractional

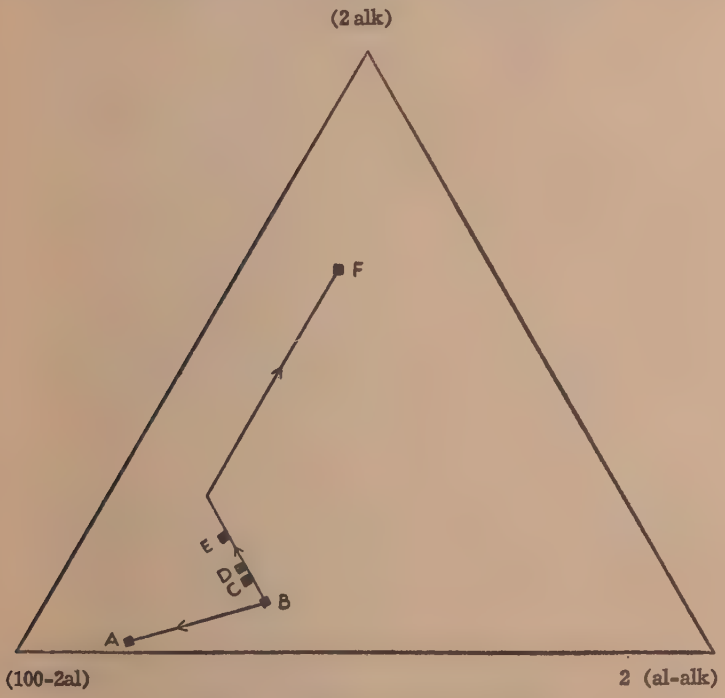

Fig. 7. Normative mineral diagram.

▩ = Dyke rocks of Pallavaram.

crystallization differentiation has switched over to tholeiitic line of descent and this is in accordance with the observation of Kuno (1937). But as these dykes carry xenoliths of country rocks and show interaction along contact zones the possibility of contamination of the magma is not altogether ruled out.

In conclusion the author wishes to emphasize that the material dealt with in this paper is too restricted to lead to a final solution of the problem of parental magma of these dykes. As the related dykes are reported by Holland (1897) to occur extensively throughout the Archaeans of Southern India there is wide scope for the

extensive study of these dykes which will shed considerable light on the basic problems of magma genesis.

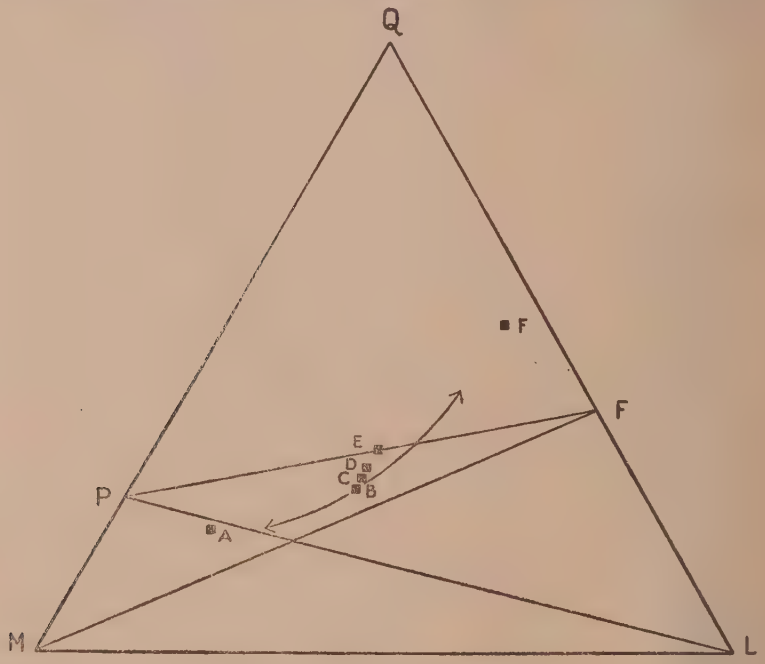

Fig. 8. Q-L-M diagram.

= Dyke rocks of Pallavaram.

ACKNOWLEDGEMENT

I embrace this opportunity of expressing my sincere gratitude to Dr. P. R. J. Naidu for his suggestions and guidance. My sincere thanks are due to Messrs. S. K. Babu and V. M. Raghavan for their kind assistance during the course of this investigation, to Mr. C. E. Nehru for preparing the microphotographs, and to Mr. Asif Ashraf for preparing field photographs.

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Explanation to Plates 1 and 2.

PLATE 1.

Fig. 1.

Field Photograph of vertical wall of dolerite dyke (DY) intrusive into the Charnockite (Ch) of Rifle Range.

Fig. 2.

Field photograph of a Xenolith of acid charnockite (A.C.) in the dolerite dyke (DY) of Mosque Hill.

Fig. 3.

Microphotograph of Pyroxenite showing hypidiomorphic texture. Enstatite (En), Hypersthene (Hy), Augite (Au) and Hornblende (Ho) occur as plates showing prismatic cleavages. × 30.

PLATE 2.

Fig. 1.

Microphotograph of Olivine dolerite showing sub-ophitic texture. Olivine (Ol) occurs as euhedral crystals. Augite (Au) shows (100) twinning and Plagioclase (Pl) occurs as laths. Enstatite (En) is present by the side of Olivine. × Nicols. × 30.

Fig. 2.

Microphotograph of Phaneritic dolerite showing sub-Ophitic texture. Plagioclase laths (Pl) occur in sub-Ophitic relation to Augite (Au). Pigeonite (P) is sparingly present. × Nicols. × 30.

Fig. 3.

Microphotograph of fine-grained dolerite showing vitrophyric texture. Glomeroporphyritic groups of pyroxene (Py) and Plagioclase (Pl) are embedded in a dense fine-grained matrix. × Nicols. × 30.

Fig. 4.

Microphotograph of fine-grained dolerite showing Pilotaxitic texture. Plexus of Plagioclase (Pl) is seen around Pyroxene (Py). × Nicols. × 30.

Fig. 5.

Microphotograph of Enstatite-Augite-Diorite showing Enstatite (En), Augite (Au), clouded Plagioclase (C. Pl) and Micropegmatite (Mp.) × Nicols. × 30.

Fig. 6.

Microphotograph of Micropegmatite showing Micropegmatite (Mp), Plagioclase (Pl) and Hornblende (Ho). × Nicols. × 30.

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Controlled Potential Electro-Gravimetric Analysis

BY

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ABSTRACT

A summary of the work, being carried out in this Laboratory on estimation of Tin by electro-deposition at controlled cathode potential is brought out. Recent advancement in electragravimetric analysis by controlled cathode potential deposition of metals, is reviewed. Complications met with in the estimation of Cu, Bi, Sb, and Pb and how they have been overcome, have been brought out by a study of the work done during the last two decades.

Introduction

Controlled potential electro-deposition is a recent advancement in electro-analytical chemistry; and the enhancement of accuracy and speed by the use of a rotating anode has entitled it for a front rank both in the macro- and micro-analytical fields. When a current is passed through an electrolyte between two electrodes, a chemical change occurs splitting up the electrolyte into positively and negatively charged ions when the applied potential reaches certain value defined as 'decomposition voltage.' These ions traverse towards the electrodes of opposite charge where their respective charges are neutralised and they get deposited primarily as metals or liberated as gases. The principle of electrogravimetric analysis is based on the definiteness of the decomposition voltage of salts in solutions.

The experimental technique is very simple consisting in weighing a platinum cathode before and after the deposition of the metal on it. In the classical constant current method there was no provision for the selectivity of electrode reaction. The application of a constant potential to the working electrode provides a means to selectively direct the deposition of the desired ion at the exclusion of the others. This control of the cathode potential is effected by setting a secondary circuit, consisting of the working cathode put in opposition to a saturated calomel electrode (S.C.E.) and

suitably altering the applied e.m.f. of the main circuit so as to keep constant the potential of the cathode with respect to the S.C.E. The electrodes most favoured for this type of analysis are the Sand's type of rotating platinum anode and stationary platinum gauze cathode.

The technique has been useful in the quantitative estimation of a large number of metals from their salt solutions and by suitably modifying the conditions it is applicable for the quantitative isolation and estimation of metals from mixtures which are otherwise difficultly separable. The present paper deals with the estimation of Tin by electro-deposition at controlled cathode potential.

Electro-gravimetric estimation of Tin from hydrochloric acid solutions dates back to the work of Schoch and Brown (1916). The early estimations of Tin by Lindsey and Sand (1934) presented errors up to a few milligrams which were attributed to probable losses of Tin by,

(a) the formation of gaseous hydride at the cathode,

(b) the volatilisation of $SnCl_4$ during the preparation of the solution,

(c) the re-dissolution of the deposit during washing, and

(d) the mechanical detachment. (Kny-Jones, et. al, 1940).

The formation of stannane is improbable under the conditions of the experiment and even if formed it will be decomposed by either Tin or by strong mineral acids. (Paneth and Rabinowitsch, 1924). Kny-Jones, Lindsey and Penney (1940) reported that the volatility of the stannic chloride during the preparation of the solution was negligible, if not nothing. In a series of electrodepositions carried out in this laboratory to investigate the probability of errors mentioned above, it was found that addition of NH_4Cl (or NaCl) to the electrolyte recommended by previous workers (Grosset, 1933) caused errors up to 4 mg of Tin and it was possible to minimise the error to 0·3 mg, by the exclusion of the salt. The error was further lessened by precoating the platinum cathode with a less noble metal (e.g.) Cu, which improved the quality of the deposit. In another series of experiments, the electrolyte containing NH_4Cl was neutralised at the end of the deposition and the error could be brought down considerably to 0·2 mg. This is in corroboration of the observations

made by Kny-Jones, et. al. (1940). These experiments go to show that the presence of NH_4Cl tends to redissolve the deposited tin to cause an appreciable error.

A more adherent coat of Tin had been reported (Kny-Jones, et. al. 1940) as a result of the addition of masking agents like oxalic acid, which keeps the effective concentration of Tin low. But the errors caused by this procedure could be minimised only by keeping the temperature above 40° C. during deposition.

The present work also verified the observation of Lindsey (1950) that the state of oxidation of Tin in HCl medium does not affect the electrolytic determination as both Stannic and Stannous solutions had been found to give equally accurate results.

Investigations of Lindsey (1950) showed that the deposition of Tin alone from stannic solutions causes very little reduction to the stannous state, but if other metals like Sb or Sb and Cu are deposited first, partial reduction to the stannous state occurs. But the experiments in this laboratory show that irrespective of the presence of the other metals, there is always a partial reduction of stannic to stannous at lower potentials. Table I gives the percentage reduction of stannic to stannous (estimated polarographically) during 1 hour electrolysis at different cathode potentials.

TABLE I

Cathode Potential (vs S.C.E.)	% reduction to stannous
— 0·1 v	0·0
— 0·2 v	3·6
— 0·3 v	14·3
— 0·4 v	32·1
— 0·5 v	Deposition starts

Deposition potential of Tin has already been found to be — 0·6 v (vs S.C.E.) and in all our experiments the cathode potential was kept at — 0·6 to — 0·8 v (vs S.C.E.) In electro-reduction experiments, it is usually recommended that the use of anodic depolarisers improves the efficiency of estimation. The efficiency of different reducing agents as anodic depolarisers was investigated

by a study of their effect on the anode potential using the procedure adopted by Lindsey and Sand (1935, p. 739). The anode potential (vs S.C.E.) was measured and plotted against the logarithm of the current density. The electrolyte consisted of 0·02 M. Tin solution to which the depolariser was added in quantities mentioned. Fig. 1 shows that Hydrazine is the most

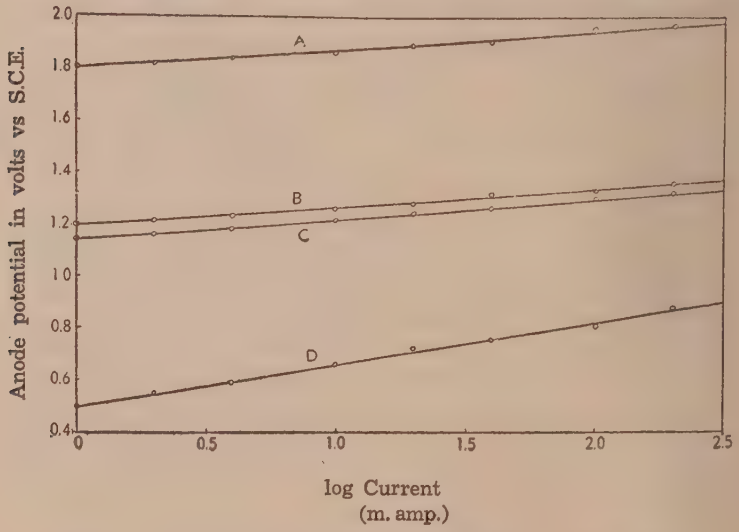

Fig. 1. Plot of Anode Potential vs Logarithm of current in a solution containing 200 mg. of Tin in 100 c.c.

A. No depolariser, B. With 0·1 M. NH_2OH. HCl,
C. With 0·5 M. NH_2 OH.HCl, D. With N_2H_4·2 HCl, 0·1 M.

efficient depolariser, reducing anode-potential by 1·2 v. From solutions of alloys of Tin with Cu and Sb, the latter metals are deposited out at — 0·4 v prior to the deposition of Sn at — 0·6 v (Lindsey and Sand, 1934, Torrance, 1937, 1938).

Pb gets co-deposited with Tin and their separation from each other was attempted in many ways. The deposit of Tin (from alloys) which contains the co-deposited Pb, is dissolved in HNO_3 and HF and the Pb is deposited as PbO_2 at the anode and Sn found by difference. Milner and Whittem (1952) dissolved the mixed deposit of Pb and Sn in concentrated HNO_3, filtered out the precipitate of metastannic acid and found lead by depositing as PbO_2. Our investigations in this method of separation showed errors to a maximum of 0·2 mg for Sn.

The property of Tin to form stable anionic complex in HNO_3 and HF medium has been exploited by Lassieur (1924) to increase the difference between the deposition potentials of Sn and Pb to effect an electrolytic separation of the two. He deposited Pb by carefully regulating the cathode potential — (0·4 v). The solution was then treated with boric acid, ammonium oxalate, and hydroxylamine and Sn deposited from the hot solution at — 0·6 to — 0·65 v. A method for isolating Sn from Cu, Bi, Pb by complexing with tartrate has been worked out by Lingane and Jones (1951). Formation of anionic complex of Tin with phosphoric acid (Aylward and Bryson, 1953) for the purpose of isolation of Tin from Pb, has been taken up for study in this laboratory and experiments were found to give errors up to 0·3 mg for the tin deposition. Use of a citrate-sulphate medium in the separation of Sn from Bi and Sb has also been reported. (Dean and Reynolds, 1954).

Hitherto the deposition of Tin from acid medium has been discussed. Deposition of Tin from alkaline solutions forms another

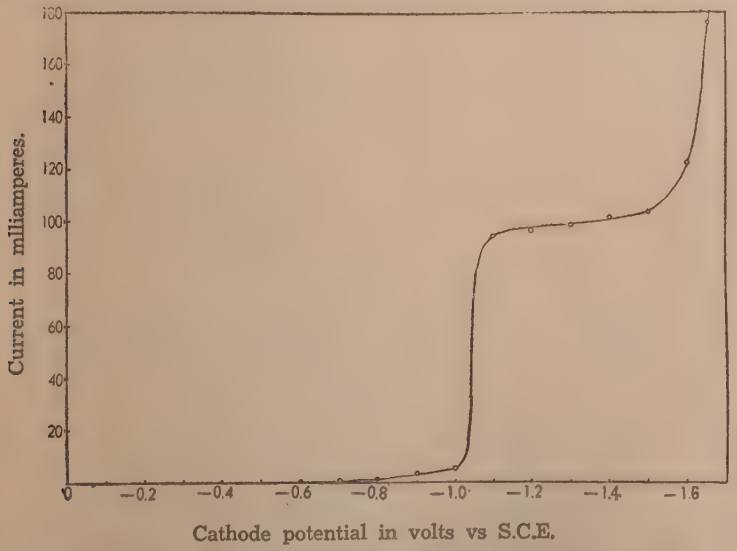

Fig. 2. Current-Cathode Potential Curve for Deposition of Tin from an alkaline solution containing 50 mg. of Tin in 200 c.c.

line of investigations in this laboratory. From alkaline medium in which the Sn is present as the complex sodium stannite it was found that the deposit is smoother and more adherent than that

from simple tin chloride. It was also found that Tin as sodium stannate is not deposited and the fact is in agreement of the study of Lingane (1943) that Stannic Tin is not reduced polarographically in alkaline medium.

Current-Cathode potential curve for the deposition of Tin from a sodium hydroxide solution (Fig. 2) shows that the deposition potential is quite sharply defined at —1·0 v (vs S.C.E.); The current rises to a limiting value between —1·1 v and —1·5 v (vs S.C.E.) at which it begins to increase again due to the decomposition of the solution of NaOH.

Experiments were conducted on the deposition of tin from alkali stannite solutions of known Tin content, maintaining the cathode potential between —1·2 and —1·3 v (vs S.C.E.), continuing the electrolysis up to the attainment of constant minimum current and carefully washing the electrode. The results were far from satisfactory revealing large negative errors, probably due to the

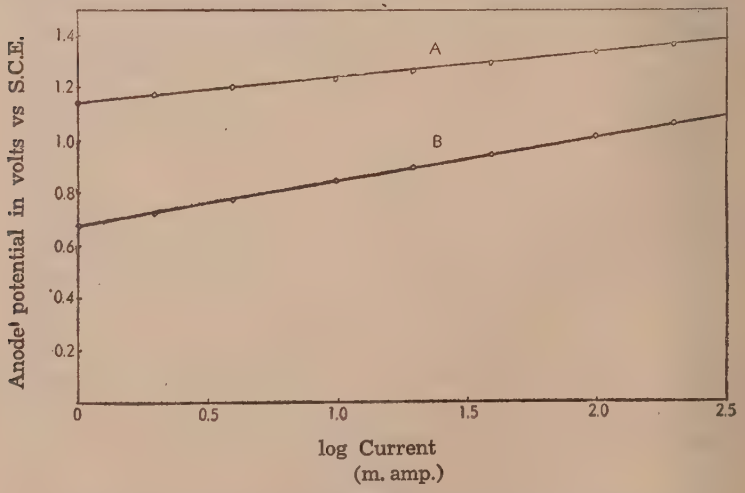

Fig. 3. Plot of Anode Potential vs Logarithm of current in a solution containing 150 mg. of Tin in 250 c.c. (as stannite).

A. No depolariser, B. With 0·1 M.N_2H_4·2 HCl.

anodic oxidation of stannite to stannate which is not reducible. In fact, addition of hydrazine as an anodic depolariser, minimised anodic oxidation and yielded results with negligible errors (Table II). Its depolarising action is demonstrated by studying its effect on the anode potential (Fig. 3). The curve shows that hyrazine maintains the anode potential 0·4 v below its value

without any depolariser. But the quantity of hydrazine hydrochloride to be added has got a maximum limit, depending on free alkali content, beyond which the hydroxide of Tin gets precipitated.

TABLE II.

No.	Tin taken gm	Depolariser at max. limit.	Tin found gm	Error g
1	0·1820	0·1 M	0·1816	— 0·0004
2	0·1820	0·1 M	0·1815	— 0·0005
3	0·1820	0·1 M	0·1817	— 0·0003
4	0·1820	0·1 M	0·1818	— 0·0002
5	0·1820	0·2 M	0·1819	— 0·0001
6	0·1820	0·5 M	0·1819	— 0·0001

Incidentally it will not be out of place if allied work, namely, electro-deposition of other metals like Cu, Bi, Sb and Pb is also presented herein.

Copper:—Copper is probably the most frequently electro-analysed element. An acid solution is generally preferred for the deposition, as otherwise there is the possibility of the formation of the hydroxide which would interfere with the estimation (Sand, 1940, p. 61). In the acidic medium, the last traces of copper form a powdery and a loose deposit due to the decomposition of a hydride formed by the interaction of copper with the hydrogen evolved at the cathode at the end of the deposition. This disadvantage has been overcome by the control of the cathode potential and by the addition of oxidising agents. (Sand, 1940, p. 61). If free nitric acid is used as an oxidising agent, the oxides of nitrogen have to be removed by the addition of urea. But Silverman (1945) prefers sulphamic acid to urea for the purpose. In free hydrochloric acid medium, a compelx of copper is formed due to the stepwise reduction of copper, and moreover a higher -ve potential has to be applied to the cathode for the completion of the deposition of copper from a chloride solution than from a solution of sulphate or nitrate (Sand, 1940, p. 60). While the

chloride solution is quite suitable for the separation of copper from lead, Tin and other metals whose deposition potentials are more -ve than — 0·4 v (vs S.C.E.), it is observed that antimony and bismuth co-deposit with copper in the hydrochloric acid medium, thereby necessitating a subsequent separation (Lingane, 1933, p. 293). However, the complex formation in the hydrochloric acid medium has been obviated by keeping the hydrochloric acid concentration low (Lingane, 1946), or as suggested by Lingane (1945) who recommends the addition of tartrate to the hydrochloric acid medium. In the tartrate buffered hydrochloric acid medium the stepwise reduction is circumvented and copper is directly reduced to the elemental form; and Lingane (1945) also reports that tartrate forms a stable complex with antimony thereby preventing its co-deposition with copper. By maintaining the pH of the tartrate buffered solution between 5 and 6 and the deposition potential at —0·3 v (vs S.C.E.) the co-deposition of Bismuth has also been eliminated (Lingane and Jones, 1951).

Torrance (1936) finds that separation of traces of copper from Tin could not be carried out under the conditions mentioned above. He recommends a sulphuric acid medium to which hydrazine is added as a depolariser. Estimation of copper in yellow and white metal alloys (Torrance, 1937), in brasses and bronzes (Milner and Whittem, 1952) and in nickel bronzes and light aluminium alloys (Torrance, 1938) is best carried out from chloride solutions in presence of free nitric acid at a voltage of — 0·36 to — 0·4 v (vs S.C.E.). Copper in its alloys with lead, antimony and tin has been successfully estimated by other workers also (Lassieur, 1924; Lindsey and Sand, 1934; Lindsey, 1938; Schoch and Brown, 1916) by the controlled potential method from hydrochloric acid solutions of the alloys. In cases where the deposits contain co-deposited antimony, the first mixed deposit is dissolved in a mixture of HNO_3 and HF, and copper alone is subsequently deposited from the solution in which antimony remains behind in the quinquevalent form as a fluoride. Aylward and Bryson (1953) has successfully attempted the isolation and estimation of copper in alloys with lead and tin by deposition from a phosphoric acid solution. Phsophoric acid keeps Tin in an anionic complex and copper and lead have been separated by controlled potential.

Bismuth:—Deposition of Bismuth at constant cathode potential has been described by Sand (1907), and Collin (1929) who

estimated Bismuth from alloy containing lead. Lindsey (1935) describes the deposition of Bismuth and Lead (as dioxide) from a nitric acid solution to which hydrazine has been added as depolariser. There was often the difficulty of incomplete deposition and non-adhering deposits (Sand, 1940, p. 60) in the hydrochloric acid medium. Good results were obtained by Schoch and Brown (1916) who deposited Bismuth from solutions containing 5% concentrated hydrochloric acid with hydroxylamine as depolariser, and they observed that careful control of cathode potential helped to make the deposit coherent. In the sulphuric acid solution, the tendency of formation of basic salts makes it impossible to work at any but high concentrations, but good results were obtained at controlled cathode potential (— 0·3 v) using hydrazine sulphate as depolariser (Sand, 1940, p. 63).

Kny-Jones (1939, p. 172) reports the formation of Oxychloride of Bismuth in the cathode layer which accounts for the sharp rise in the auxiliary cathode potential during the electro-deposition Oxalic acid acts as a solvent for oxychloride and helps to keep the cathode potential under control. Kny-Jones (1939, p. 575) also shows that the tendency of Bismuth to deposit on the anode from nitric acid-sulphuric acid medium can be eliminated by the use of hydrazine as depolariser. Bismuth has been rapidly isolated from copper and determined accurately in alkaline-cyanide-tartrate solutions (Kny-Jones, 1941) by the use of hydroxylamine as depolariser. Tartrate buffered acid medium of controlled pH provides for an excellent separation of Bismuth from Lead, Tin and Antimony and baser metals (Lingane & Jones, 1951). After copper has been deposited from the solution at pH 5·8 to 6·0 and at —0·3 v (vs S.C.E.), Bismuth can be deposited at an optimum pH ranging between 5·2 and 5·4 at —0·4 v (vs S.C.E.). Citrate-sulphate buffers have been used by Dean and Reynolds (1954) in the separation of Bismuth from antimony and tin. Bismuth is removed at a potential of —0·3 v (vs S.C.E.), while antimony forms a complex with citrate.

Antimony:—Antimony offers more difficulties than others for quantitative electro-deposition from acid solutions due to non-adherent deposits and incomplete deposition. Except in the presence of highly concentrated sulphuric acid, the hydrolysis prevents complete deposition and there is the necessity of keeping the solution in the antimonous state (Sand, 1940, p. 66). In hydrochloric acid solution, though the reduction to the antimonous state takes place more readily, the deposit has been found to be loose

unless the cathode potential is regulated with care. The sponginess of the deposit has been attributed to the intermediate formation of stibine. Higher values have sometimes resulted from the inclusion of halides, oxides and sulphides by the deposit, as when alkali sulphide solutions are used (Treadwell & Hall, 1942, p. 93). These errors can be eliminated by the maintenance of proper temperature (generally 70°), cathode potential (— 0·4 v vs S.C.E.) and addition of hydroxylamine hydrochloride as depolariser (Sand, 1940, p. 67; Schoch & Brown, 1916). The inclusion errors have been eliminated by carrying out the deposition of antimony on an amalgamated cathode (Sand, 1940, p. 66). Presence of sulphides generate polysulphides at the anode and prevents the deposition of antimony partly or at times completely or redissolves the deposit by oxidising it to Na_3SbS_3 (Treadwell & Hall, 1942, p. 93). Addition of KCN to the solution promotes the formation of thiocyanate and prevents the formation of polysulphide at the anode.

The co-deposition of copper and Bismuth with Antimony at the same cathode potential (Lingane, 1953 p. 293) and a method of their subsequent separation have been dealt with earlier (Lindsey & Sand, 1934; Torrance, 1937). Antimony has also been separated from other metals taking advantage of the fact that antimony in antimonic state is not deposited from aqueous alkaline solutions or fluoride solutions (Sand, 1940, p. 66).

Lead:—Lead has been deposited electrolytically either as metal on the cathode or as peroxide on the anode. In the former case, a reducing agent must be added as anodic depolariser to prevent the deposition of PbO_2 on the anode and conversely in the latter case an oxidising agent as cathodic deploriser, to prevent the deposition of Pb on cathode (Sand, 1940, p. 73). Deposition of lead as PbO_2 is generally preferred to its deposition as Pb (Sand, 1940, p. 74) because of :

(i) the tendency of lead to get oxidised on drying and

(ii) the tendency of lead to form an alloy with and consequently deteriorate the platinum cathode (Collin, 1929).

Perchloric acid is generally added to the nitric acid solution as it is found to give a more adherent and compact peroxide deposit (Norwitz, 1951).

Electrolytic determination of lead and its separation from Bismuth by graded potential was carried out by Sand (1907),

Collin (1924) and Lindsey (1935). In all cases, Bismuth was first isolated at a controlled potential and subsequently lead was deposited as metal by Sand and as peroxide by Collin and Lindsey.

A chapter on Separations by Sand (1940, p. 86) discusses the possibilities of separation and determination of metals in various other combinations. A procedure is given by Lingane (1953, p. 312) to successfully determine Cu, Bi, Pb and Sn in a single sample and a Table (Lingane, 1953, p. 313) summarises the examples of separation and determination of various metals.

Conclusion.

The above paras will clearly go to show the comprehensiveness of the technique of the electrolytic deposition as applied to the quantitative determination of metals. The controlled cathode potential method is receiving increasing attention in the industry for the separation of metals commonly found alloyed together such as those that are dealt with in the course of this paper.

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Life History of the Psammophilous Copepod *Leptastacus euryhalinus*

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ABSTRACT

The developmental stages of *Leptastacus euryhalinus* a psammophilous harpacticoid copepod are described fully.

INTRODUCTION

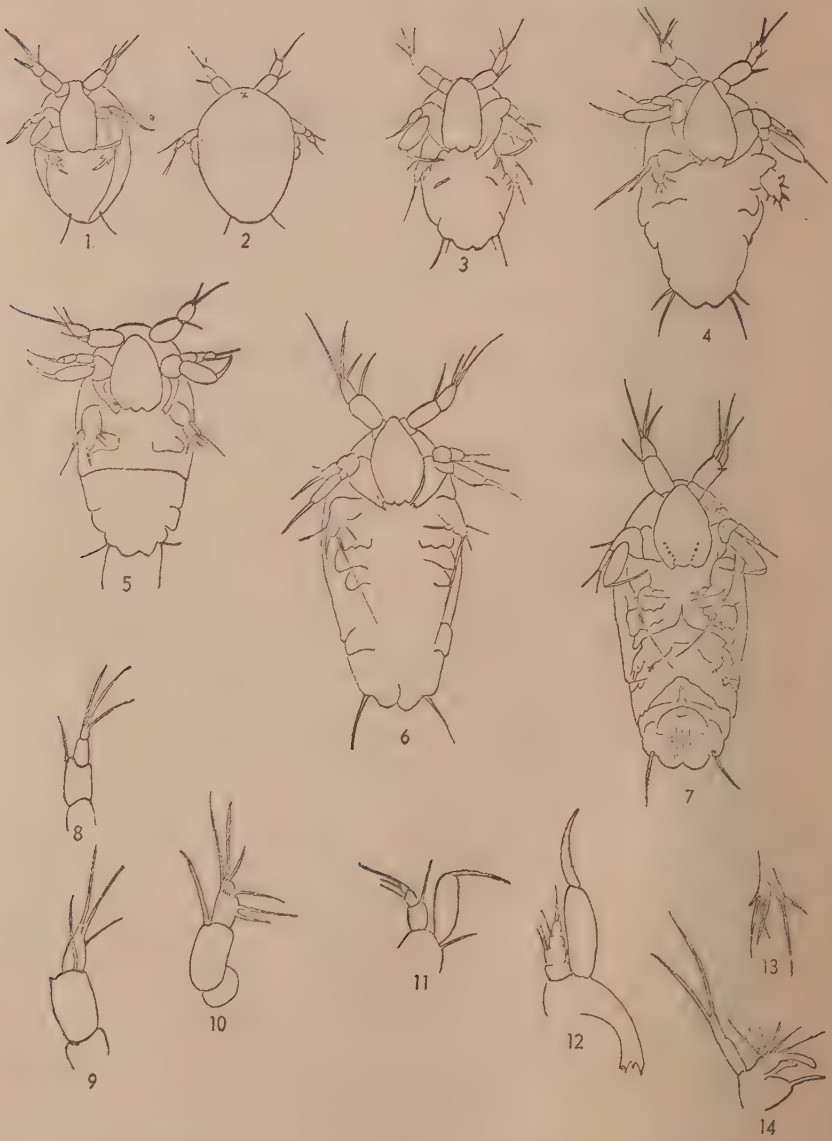
In spite of the keen interest evinced in the study of the taxonomy of the psammophilous copepods, there has been no attempt to work out the life history of these forms so far. The occurrence of large numbers of *Leptastacus euryhalinus* at Madras afforded an opportunity to study the development of this copepod. A complete account of the life history is given in the present paper.

Leptastacus euryhalinus is a psammophilous harpacticoid, which occurs in large numbers on the sandy banks of the Cooum estuary at Madras. At the time of collection, the salinity of the water was $18 \cdot 2^0/_{00}$. During rainy seasons there is a considerable admixture of rain water and hence the salinity shows great fluctuations. Experiments performed in the laboratory shows that this copepod can tolerate even sea water with a salinity of $31 \cdot 2^0/_{00}$. This copepod was found to be very hardy and could be easily reared in small containers with sand kept moist by sprinkling water once a day.

The eggs: are spherical in shape and coloured red, measuring 60μ. Usually five eggs are uniserially arranged in an egg-sac. All the eggs contained in an egg-sac hatch out more or less to-gether.

Nauplius: The nauplius is dorsoventrally compressed and the large labrum probably helps it to adhere to the surfaces closely. The newly hatched nauplius is of a faint dirty yellow colour with an eye coloured red. There are six naupliar stages.

Nauplius, stage I, (figs. 1 & 2)—is oval in shape, being narrower than long, measuring about 0·067 mm. long. Labrum is large. A



Figs. 1-14.

Fig.1-7. Naupliar stages, 1 to 6. Fig. 8. Antennule, nauplius, first stage. Fig. 9. Antennule, nauplius, third stage. Fig. 10. Antennule, nauplius, sixth stage. Fig. 11. Antenna, nauplius, first stage. Fig. 12. Antenna, nauplius, fifth stage. Fig. 13. Mandible, nauplius, first stage. Fig. 14. Mandible nauplius, fifth stage.

pair of fine setae are borne on the posterior margin. The *antennule* (fig. 8) is three jointed with one seta on the basal joint and three on the terminal joint. The *antenna* (fig. 11) has a well developed masticatory spine. The endopod is long and prehensile, armed with a claw. The exopod is three jointed, the first two joints carrying a seta each, and the terminal joint two setae. The *mandible* (fig. 13) has a single jointed exopod which bears two long setae, while the endopod carries four setae.

Nauplius, stage II: (fig. 3) shows an increase in size (0·79). The posterior side is bifid in the middle and two setae are borne on the distal corners. Labrum is tri-lobed and large. The *antennule* is three articled as in the previous stage. *Antenna* and *mandible* as in the previous stage.

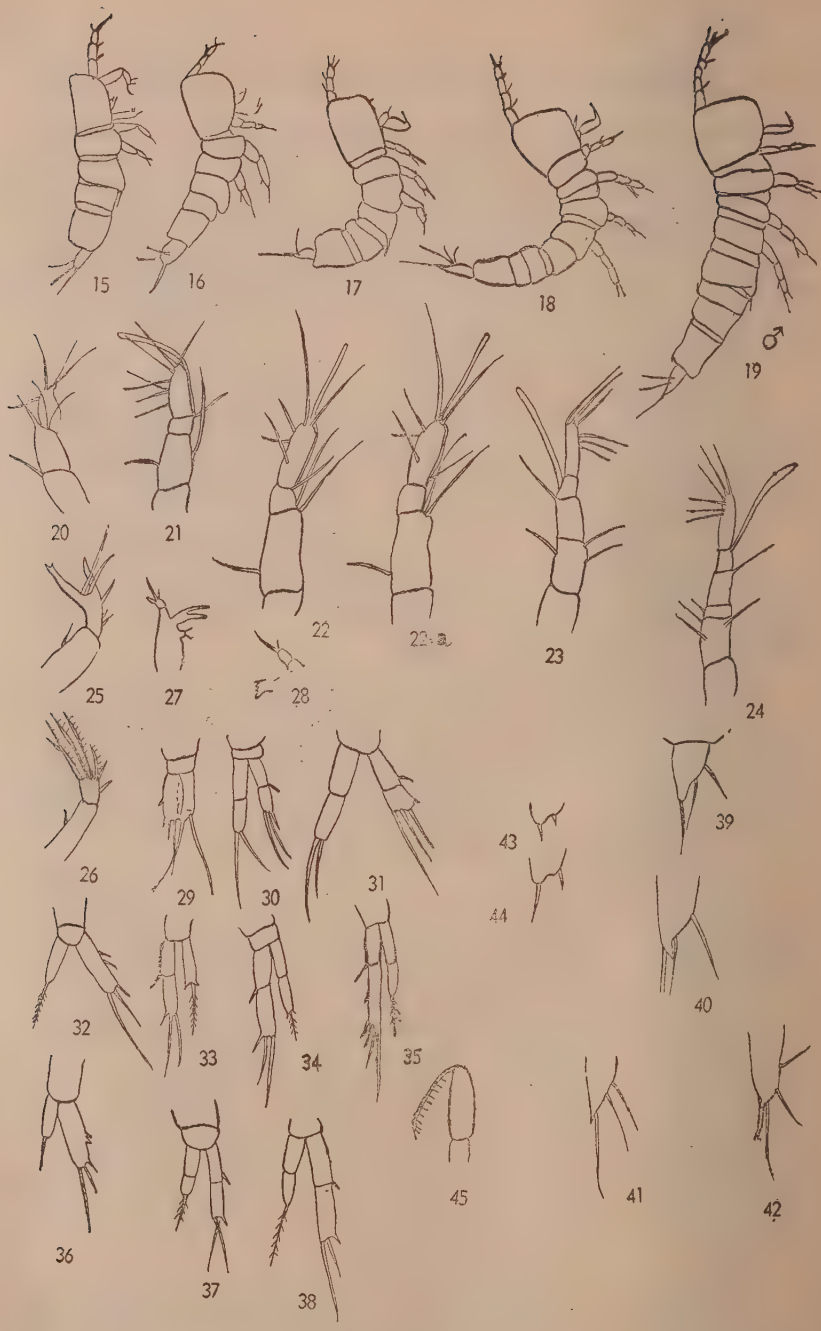
Nauplius, stage III: (fig.4) is longer than wide, measuring 0·096 mm. long. Labrum tri-lobate as in the previous stage. The *antennule* (fig. 9), *antenna*, and *mandible* as in the previous stage. Rudiments of *Maxillae* are visible.

Nauplius, stage IV: (fig. 5). The body shows a division into an anterior and a posterior half. The posterior region is bifid in the middle and the two halves are again divided, each lobe carrying a seta. Labrum is large, with the posterior end tri-lobed. *Antennule, antenna* and *mandible* as in the previous stage. Rudiments of *maxillae* and *maxilliped* are discernable.

Nauplius, stage V: (fig. 6). measures 0·121 mm. long, and is longer than broad. The masticatory process on the *antenna* is well developed. Besides the *maxillae* and the *maxilliped*, rudiments of two pairs of swimming feet are also visible.

Nauplius, stage VI: (fig. 7) Resembles the previous stage, but is larger in size, measuring 0·130 mm. long. The *antennule* is three jointed, armed as in the previous stages, but the terminal joint carrying three lateral and three terminal setae (fig. 10). The exopod of the *antenna* is four jointed, the second joint carrying two setae and the third and the fourth joints a seta each. (fig. 12). The *mandible* is well developed with a two jointed exopod, the terminal joint of which bears two setae.

There are six copepodite stages as in other free living copepods. The first copepodite (fig. 15) is small and slender, measuring 0·21 mm. long, with a two jointed urosome. The furcal ramus is longer than broad, and carries three setae. (fig. 39). The *antennule* is three jointed, the joints carrying one, three and four setae



Figs. 15-45.

Figs. 15-19. Copepodites 1 to 5. Figs. 20-24. Antennule. Figs. 25 & 26. Antenna. Fig. 27. Maxilla. Fig. 28. Mandible. Figs. 29-31. First leg. Figs. 32-35. Second leg. Figs. 36-38. Third leg. Figs. 39-42. Furcal ramus. Figs. 43-44. Fifth leg. Fig. 45. Maxilliped,, fifth stage.

(All the figures were drawn under a magnification of 280 ×)

respectively (fig. 20). The *antenna* is two jointed. The basal joint is long and slender and the distal joint has two spines and two setae terminally, and a seta on the inner side (fig. 25). The exopod is represented by a single seta. The *mandible palp* is two jointed as in the adult (fig. 28). The *maxillae* and the *maxilliped* could not be made out clearly. In the first leg, the rami are one jointed (fig. 29). $Basal_2$ is devoid of setae. The exopod is short and has two lateral spines and two apical setae, and the endopod which is longer than the exopod, carries two setae apically. In the second leg (fig. 32) the one jointed exopod is longer than the endopod and carries three lateral spines, and two apical setae. The single jointed endopod is short and carries an apical plumose spine.

The second copepodite is slightly larger than the previous stage measuring 0·214 mm. long (fig. 16). The *antennule* is three jointed as in the previous stage, carrying one, four, and five setae respectively. There is no essential difference in the structure of the *antenna* and the mouth parts. In the first leg (fig. 30), the rami are two jointed. The first joint of the exopod has one outer spine, and the second joint one outer spine and two apical setae. The distal joint of the endopod carries two setae. The exopod of the second leg (fig. 33) is also three jointed, whereas, the endopod is only one articled. The first joint of the exopod has one outer spine and the second joint one outer spine and two apical setae. The endopod which is shorter than the exopod, carries one apical seta.

The third copepodite stage measures 0·273 mm. long (fig. 17). The urosome is three jointed. The furcal ramus is longer than broad and has one apical and two lateral setae (fig. 40). The antennule (fig. 22) is four jointed, the setation being as follows:—

Joints :	1	2	3	4
Setae :	-	3	1 a	7

The antenna: the exopod is represented by a seta attached to the basal joint about the middle. The endopod is small and has two lateral spines and four apical setae. The mouth parts as in the previous stage. Both the rami of the first leg are two jointed (fig. 31). The first exopod joint has an outer seta, and the second joint one outer and three apical setae. The endopod is slightly longer than the exopod and its distal joint has two terminal setae. In the second leg also the rami are two articled. (fig. 34). The first exopod joint carries one outer spine and the second joint one outer spine and two apical setae. The endopod is shorter than the exopod, extending only a little beyond the first exopod joint, and

distally carries an apical plumose seta placed between two spinules. The basal$_2$ of the third leg has an outer seta (fig. 36), and the rami are one jointed. The first joint of the exopod has four lateral spines and an apical seta. The endopod which is shorter than the exopod carries an apical seta. The fourth leg is rudimentary.

The sexes are distinguishable at the fourth copepodite stage. The furcal ramus has two outer and one apical seta. (fig. 41) The antennule (fig. 22) is four jointed, short, and alike in both the sexes.

The setae are distributed as follows:

Joints	1	2	3	4
Setae		3	1 a	5

Antenna has a one jointed exopod which is tipped with two setae. The rami of the first leg are two jointed, the first joint of the exopod has one outer spine, and the second joint one outer spine and two apical setae. The endopod is longer than the exopod and its second joint carries two setae terminally. The rami of the second leg are two jointed as in the previous stage (fig. 35). The first joint of the exopod has an outer spine and the second joint two outer spines and three apical setae. The endopod is slightly shorter than the exopod and has a seta as in the previous stage. In the third leg, the rami are two articled. The first segment of the exopod has an outer spine and the second, one outer spine and two apical setae. The endopod is shorter than the exopod, its terminal joint having one seta. The rami of the fourth leg are one jointed. The exopod has one apical and two outer spines and two spinules. The endopod which is shorter than the exopod has a terminal seta. The fourth leg follows the same course of development as the third leg. The fifth leg is represented by a small triangular lamina in both the sexes.

Length : ♀ 0·327 mm; ♂ 0·321 mm.

The sexes can be easily distinguished in the fifth copepodite stage.

The female: Measures 0·54 mm. long. The urosome consists of four segments as in the adult. The furcal ramus is produced acutely and carries one apical and two lateral setae, and one arising from the base of the innermost seta and at the base of the second seta.

The antennule is six articled, (fig. 26). The setation is as follows.

Joints	1	2	2	3	4	5	6
Setae			3	i	i	a	6

The mouth parts and the first three pairs of legs are as in the previous stage. The rami of the fourth legs are, however, two jointed. The fifth leg is represented by a lamina.

The Male: (fig. 19). Measures 0·499 mm. long. The urosome consists of five segments as in the adult. The antennule (fig. 23) is five jointed, and the setae are distributed as follows:

Joints	1	2	3	4	5
Setae		3	1	a	6

The third joint is slightly swollen. The first four pairs of legs are as in the female. The fifth leg is represented by a small triangular lamina.

Remarks: The development of this typical sand-dwelling copepod shows that in all the essential features it resembles that of other copepods from other habitats. The features of interest are the flatening of the body and the reduction in the setae borne by the appendages. It deviates from the typical harpacticoid nauplii in the shape of the body, being longer than wide, and in the presence of a large labrum, but agrees in the prehensile nature of the endopod of the antenna and the presence of large mandibular process on the coxa. In the copepodite stages, the development is gradual and normal. It is of interest to note that this copepod passes through the six copepodite stages as many free swimming forms from other habitats.

ACKNOWLEDGEMENT

The author takes this opportunity to thank Prof. C. P. Gnanamuthu, Director, Zoological Research Laboratory, for the guidance and help.

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BOOK REVIEW

Elements of Zoology. By T. I. Storer and R. L. Usinger (McGraw-Hill Book Co.), 1955, pp. XII+552. Price $5·50.

The authors T. I. Storer and R. L. Usinger have given us, teachers and students of Zoology in India, a hand book embodying a generalised treatment of the fundamentals of Zoology. The book is divided into two parts (i) The animal biology and (ii) the animal kingdom. All the essentials of cytology, distribution and evolution are presented in the simplest and yet convincing manner, in part I. In part II the comparative anatomy of the invertebrates and vertebrates is treated from the evolutionary point of view, in a way which shows how without types and elaborate classification, a sound knowledge of biology can be conveyed.

This book will be received with welcome by both teachers and students of the University of Madras and other places, where the entire system of college education is being revised and the old order of loading the students with dry details of anatomy and classification, is changing and yielding place to the new order where biological principles and generalisations will be emphasized and when even the students of humanities may be given courses in elements of Zoology.

The get up and illustrations, bearing as they do the usual stamp of McGraw Hill excellence, are other commendable features.

—C. P. Gnanamuthu

ABSTRACTS OF PAPERS PUBLISHED FROM DEPARTMENTS OF SCIENCE, UNIVERSITY OF MADRAS

Madras University : Department of Botany

Abstracts of Papers Published, 1954-55.

75. **Lakshminarayanan, K.:** Microchromatography I. A technique for separation and identification of traces of amino acids, sugars, etc. *Arch. Biochem. Biophys.* 51; 367-70, 1954.

A simple micro-technique is described for the chromatographic separation and identification of traces of amino acids, sugars etc., in the order of 0·25 μg. on filter paper disks of 2·3 cm. diam. by employing fine capillary tubes for irrigation. The developed chromatograms are mounted on a microscope slide under a cover slip and examined under the microscope using suitable color filters. Consistent and reproducible Rf values comparable to those of larger chromatograms have been obtained.

76. **Kalyanasundaram, R.:** Soil conditions and root diseases. XIII. Symptomatology of *Fusarium* wilt. *J. Indian bot. Soc.*, 33: 329-38, 1954.

A complete study of symptomatology of cotton plants infected by *Fusarium vasinfectum* was made. The 'vein clearing' on the leaves caused by this causal agent was the earliest visual symptom. Three major types of 'vein clearing' observed have been described with a reference to symptomatological similarity between certain virus infections and this root-infecting pathogen. The progression of 'vein clearing' in a three month old cotton plant is described with a diagramatic representation.

The anatomy of leaves showing 'vein clearing' indicated that the chlorenchyma aligning the vascular bundles were affected, especially the plastids inside them. The chlorophyll content of the diseased leaves was lower than that of healthy plants as well as the disease escaped plants.

Leaves from infected plants indicated inhibition of starch synthesis along the regions of 'vein clearing' when tested for starch after a light period. When tested, however, after a dark period starch translocation was indicated in the earlier stages of the disease. It was possible by this starch test (conducted after a light period) to indicate the path of toxin(s) movement much in advance of the visible symptom. Starch test as a diagnostic method of early wilt symptoms in plants infected by *Fusarium vasinfectum* is reported here for the first time.

77. **Lakshminarayanan, K.:** Microchromatography. II. Detection of trace elements in biological media. *Proc. Indian Acad. Sci.*, B, 40: 167-72, 1954.

A simple method for the chromatographic separations of inorganic cations in mixtures and in biological media in the order of 0·15 to 0·2 μg. has been described. Different spray reagents for the detection of the cations and also their Rf values in three solvent mixtures, N-Butanol-accetic acid-water, aqueous collidine and aqueous lutidine have been reported.

78. **Subba Rao, N. S.:** Fluorescence phenomenon in fusariose wilt of cotton. *J. Indian bot. Soc.*, 33: 443-45, 1954.

Cotton plants grown in *Fusarium vasinfectum* infected soils, when examined under ultraviolet illumination, revealed characteristic fluorescence of stems and veins of leaves. The healthy plants grown in sterilised uninoculated soil, however, did not fluoresce.

Aqueous extracts of infected cotton plants exhibited fluorescence *in vitro* similar to that of the dialysed culture filtrate of the pathogen responsible for the wilt of cotton.

Microscopic examination of transections of infected plants under ultraviolet light revealed characteristic fluorescence of vascular region only.

The probable cause for the flourescence of stem and veins of infected cotton plants and the possibility of utilising it for screening infected plants under field conditions are discussed.

79. **Sadasivan T. S.:** The role of trace elements in control of root-infecting fungi. *Proc. 7th Internat. bot. Congr., Stockholm*, 195-96, 1950.

This paper discusses results of investigations on the response of three species of *Fusarium—F. vasinfectum, F. udum* and *F. moniliforme*—producing wilt on cotton, red-gram and paddy, respectively, both in pure culture and soil environment to trace elements.

80. **Iyengar, M. O. P., & Ramanathan, K. R.:** On a new species of *Halicystis* from South India. *J. Indian bot. Soc.*, 33: 446-52, 1954.

An account is given of a new species of *Halicystis, H. Boergesenii*, from South India. It grows on crusts of *Lithothamnion* on the coral reef of southern side of Krusadai Island near Pamban in the Gulf of Manaar in South India.

The alga has a small vesicle about ½—2 mm. in diameter and has a vertical rhizome which may reach a length of up to 2 mm. The rhizome is branched at its extreme lower end. Some of the branches grow horizontally and give rise to new *Halicystis* daughter-plants by stoloniferous growth.

The vesicle portion dies out after a time, and then disintegrates and disappears. The rhizome portion, however, is perennial and, when the vesicle dies, a new vesicle is regenerated in its place from the upper end of the stalk. In this way new vesicles are regenerated by the stalk for a number of seasons.

Discharge of gametes from the vesicle and sexual reproduction were not observed.

The genus *Halicystis* has been known so far only from the Eastern and the Western Atlantic, the Eastern Pacific and the Mediterranean. The occurence of the present *Halicystis* in the Indian Ocean is therefore very interesting.

81. **Saraswathi-Devi, L., (Miss):** Polythene and heavy metals. *Curr. Sci.*, **23**: 409, 1954.

Polythene wash-bottles were tested biologically for their heavy metal impurities using *Aspergillus niger* van Tiegh. Polythene was found to be free of Fe, Zn, Co, Mn and Mo showing thereby that polythene containers may be used in biological studies with the above heavy metals.

82. **Venugopal, S. & Venkataramani, K. S.:** An agromyzid insect pest of "Bhendi". *J. Madras Univ., B*, 24: 335-340, 1954.

This article records the first occurrence of *Agromyza obtusa* Mall. (the red-gram of 'turpod' fly) as a pest of 'bhendi', *Hibiscus esculentus* L., in S. India. The maggot bores through the stem tissue of young plants and side-shoots of mature plants resulting in the wilting and death of the affected plants of branches. Considerable damage is at times caused by this pest. All varieties examined are susceptible, but a few with a profuse hairy growth on the stem appear to be comparatively resistant. Spraying the plants with either BHC or DDT (0·05) or 0·1 per cent.) at fortnightly intervals controls the pest to an appreciable extent.

83. **Sadasivan, T. S., Subramanian, C. V., Ramakrishnan, K., Kalyanasundaram, R., Venkata Ram, C. S., Lakshminarayanan, K., Saraswathi-Devi, L. (Miss), & Lakshmanan, M.:** Symposium on soil micro-organisms and plant well-being. *Proc. Indian Acad. Sci.*, B, **41**: 97-154, 1955.

The modern views on *in situ* production of antibiotics in soils and their uptake by plants and the role of heavy metals in the production of these toxins, the derangement in uptake of metabolites by plants and its repurcussions on amino acid sequence of fungal wilt polypeptide toxins are discussed by Sadasivan. The more recent work on root exudations in plants and their import on rhizophere microfloras is presented.

Subramanian discusses the ecological and taxonomic problems in the genus *Fusarium*.

Some aspects of the synecology of soil fungi are discussed by Ramakrishnan. He also reviews the techniques evolved for the study of soil fungi with special reference to the "dilution plate" and "root burial" techniques.

Certain aspects of variation and variability in the genus *Fusarium*, formation of variants by different means, and how these affect the taxonomy of the genus are discussed by Venkata Ram.

The *in vivo* reactions of cotton plants infected by *F. vasinfectum* as indicated by ascorbic acid and carbohydrate metabolism as well as the factors affecting the *in vitro* action of the pure toxin, fusaric acid, produced by this pathogen are discussed by Kalyanasundaram. The antibiotic potency of this phytotoxin, its production and role in soil are also discussed.

Lakshminarayanan reviews the theories of fusariose wilts of plants with special reference to N_2 distribution and derangement in cotton wilt. He also discusses the chromatographic survey of nitrogenous constituents in the plants and the possible role of iron and cystine in the mechanism of resistance.

The indispensability of heavy metals in fungal nutrition is discussed by Saraswathi-Devi, stressing the care and experimental precautions involved in bringing out their essential nature. The effects of certain heavy metal deficiencies on growth and metabolism of some vascular wilt pathogens (*Fusarium* spp.) are given.

Lakshmanan discusses the respiratory changes in cotton plants (resistant and susceptible strains) with reference to *Fusarium* wilt of cotton. Respiratory changes brought about by toxins and growth substances are also dicussed.

84. **Appa Rao, A., Subba Rao, N. S., & Suryanarayanan, S.:** Influence of the culture filtrate of *Fusarium vasinfectum* Atk. on *Piricularia oryzae* Br. et. Cav. *Curr. Sci.,* 24: 125, 1955.

The dialysed and autoclaved culture filtrate of *Fusarium vasinfectum* was shown to have thiamine replacement value by growing *Piricularia oryzae*—a thiamine deficient fungus—in the culture filtrates of *Fusarium vasinfectum.*

85. **Appa Rao, A., Saraswathi-Devi, L. (Miss), & Suryanarayanan, S.:** Growth requirements of *Piricularia oryzae* Br. et Cav. *J. Indian bot. Soc.,* 34: 37-42, 1955.

An isolate of *Piricularia oryzae* Br. et Cav., found to be mainly thiamine-heterotrophic on a sucrose-nitrate medium, was studied further with regard to its heavy metal nutrition in purified liquid cultures. In the present state of experimental evidence presented here it is concluded that thiamine, and iron and zinc, and possibly copper, are indispensable but, nevertheless, interdependent in their action in so far as it relates to this strain of *P. oryzae.*

86. **Kalyanasundaram, R.:** Bioassay of *Fusarium* toxin. Agar-cup method for quantitative evaluation. *J. Indian bot. Soc.,* 34: 43-46, 1955.

Using a strain of bacterium isolated from the laboratory garden soil a technique for the quantitative bioassay of fusaric acid, one of the toxins of *F. vasinfectum,* has been developed following the standard agar-cup method. The logarithm of concentration of the toxin/antibiotic and the diameter of zone inhibition bear a linear relationship. The possibility of extending this technique in toxicological studies of this wilt pathogen is discussed.

87. **Subramanian, C. V.:** Studies on South Indian Fusaria IV. The "wild-type" in *Fusarium udum* Butler. *J. Indian bot. Soc.*, **34:** 29-36 1955.

The results of a detailed study of the 'wild type' in *Fusarim udum* Butler (the fungus causing vascular wilt in *Cajanus cajan*) are presented. In first cultures the fungus exhibited considerable variation in cultural characters, although the majority of the isolates were characterised by poor development of aerial mycelium and prolific production of micro- and macro-conidia in pionnotes or in sporodochia. Morphologic characters of conidia produced by the isolates were much less variable and these are therefore considered to be of diagnostic value for the species. On the basis of the data presented, it is concluded that no fixed or rigid 'wild-type' concept can be formulated for *F. udum*—a fact which is presumably of general application to other species of the genus.

88. **Agnihothrudu, V.:** Some slime-moulds from Southern India —III. *J. Indian bot./Soc.*, **34:** 85-91, 1955.

The following species of slime-moulds are reported and illustrated: *Physarum cinereum* Persoon, *P. virescens* Ditmar, *P. serpulo* Morgan, *P. echinosporum* Lister, and *P. bitectum* Lister.

89. **Sadasivan, T. S. & Subramanian, C. V.:** Studies in the growth requirements of Indian fungi. *Trans. Brit. mycol. Soc.*, **37:** 426-30, 1954.

Twenty-six isolates of fungi from different host plants were tested for vitamin requirements. Eleven isolates (including several morphologically similar isolates of *Pellicularia koleroga*) were heterotrophic to thiamine, but their capacity to synthesize this vitamin was not completely lost as they do so from a mixture of thiazole and pyrimidine or from pyrimidine alone. *Piricularia oryzae,* however, was unable to do this in young cultures, but with advancing age utilized an equimolar mixture of thiazole and pyrimidine or pyrimidine alone. Some isolates were also tested for growth response with riboflavin, biotin and pantothenic acid. A strain of *Aspergilius niger* isolated from Indian soil was more sensitive in detecting traces of copper and molybdenum than the standard *A. niger* 'M' strain used for bioassay of heavy metals.

90. **Subramanian, C. V.:** Vivotoxins and Fusariose wilts in plants. *Curr. Sci.*, **24:** 144-47, 1955.

The mechanism of vascular wilts of plants is critically discussed with special reference to the toxin theory of wilts. It is considered that the possibility of direct invasion and damage to host roots by toxic metabolites produced in soils is remote. The necessity for using rooted plants instead of cut shoots in all experiments on the action of culture filtrates of plant pathogens is emphasized.

91. **Kalyanasundaram, R., & Saraswathi-Devi, L. (Miss):** Zinc in the metabolism of *Fusarium vasinfectum* Atk. *Nature, Lond.*, **175;** 945, 1955.

A relationship between zinc concentrations and antibiotic production in a purified medium by *Fusarium vasinfectum* is demonstrated. Antibiotic production was completely inhibited above a concentration of 100 μg. of zinc (in 25 ml. medium) while below a concentration of 2 μg. (in 25 ml. medium) no antibiotic was detectable. Optimum concentration lay between 6-8 μg. (in 25 ml. medium).

92. **Iyengar, M. O. P., Ramakrishnan, K., & Subramanian, C. V.:** A new species of *Sapromyces* from South India. *J. Indian bot. Soc.*, **34**: 140-145, 1955.

Sapromyces indicus sp. nov., an aquatic Phycomycete (Leptomitales, Rhipidiaceae), is described from Kambakkam, Madras State. This species differs from the other known species of *Sapromyces*, in having oospores with reticulately thickened walls and in the size of the sporangia and the basal pseudocell. The taxonomic criteria useful in delimiting genera in the Rhipidiaceae are discussed.

93. **Subramanian, C. V., & Ramakrishnan, K.:** On *Discella cedrelae* Ramakr. T. S. and K. *J. Indian bot. Soc.*, **34**: 225-26, 1955.

On the basis of a critical study of the type specimen of *Discella cedrelae* Remakr., T. S. and K. on *Cedrela toona* Roxb., the fungus is transferred to the genus *Didymochora* Hoehn. (Leptostromaceae-Phaeodidymae) as *Didymochora cedrelae* (Ramakr., T. S. and K.) Subram. and Ramakr.

94. **Kalyanasundaram, R., & Saraswathi-Devi, L. (Miss):** Synthesis of ascorbic acid by *Fusarium vasinfectum* Atk. *Curr. Sci.*, **24**: 273-74, 1955.

It is shown that ascorbic acid is synthesized by *Fusarium vasinfectum* in the early stage of its growth and that zinc has a role in the process.

95. **Kalyanasundaram, R.:** Antibiotic production by *Fusarium vasinfectum* Atk. in soil. *Curr. Sci.*, **24**: 310-11, 1955.

The production of antibiotic by *Fusarium vasinfectum* in sterilized soil is reported.

96. **Agnihothrudu, V., Bhuvaneswari, K. (Miss) & Suryanarayanan, S.:** Fungi isolated from Rhizosphere—I. *Proc. Indian Acad. Sci.*, B, **42**: 98-104, 1955.

The following fungi isolated from the rhizosphere of crop plants are reported and illustrated. (1) *Melanospora brevirostrata* C. Moreau. (2) *Stachybotrys atra* Corda (3) *Aspergillus giganteus* Wehmer; (4) *Oedocephalum coprophilum* Kobayasi; (5) *Dendryphion interseminatum* (Berk. and Rav.) Hughes.

97. **Lakshminarayanan, K., & Subramanian, D.:** Is fusaric acid a vivotoxin? *Nature, Lond.,* **176**: 697-98, 1955.

Fusaric acid, one of the wilt toxins produced by Fusaria, was detected as its copper chelate in roots, shoots and leaves of wilting cotton plants and conclusively established to be a vivotoxin in the *Fusarium* wilt of cotton.

98. **Kalyanasundaram, R.:** Soil conditions and root diseases—XIV Host-parasite response to *Fusarium* wilt. *Proc. Indian Acad. Sci.,* B, **42**: 145-53, 1955.

The toxin of *F. vasinfectum,* fusaric acid, has no host specificity despite the fact that there is specificity of hosts infected by this pathogen.

Resistant cotton plants (*Gossypium hirsutum*), in spite of being infected by *F. vasinfectum* do not manifest visual symptoms. A study of their metabolism clearly indicates that resistance is due to the higher reserve of carbohydrates and ascorbic acid over the susceptible plants. It is likely that these energy-yielding substances are favourably utilised in the resistant plants for the formation of a labile toxic substance which inhibits the pathogen inside the vascular system.

99. **Venkataram, C. S.:** Soil Fusaria and their pathogenicity. *Proc. Indian Acad. Sci.,* B, **42**: 129-44, 1955.

Eleven fields situated in the cotton growing tracts of Coimbatore and Tirunelveli districts in Southern India were investigated for the occurrence of Fusaria with reference to the variability in the pathogenic manifestation of the different species inhabiting these soil types.

F. chlamydosporum, F. culmorum, F. oxysporum and *F. solani* were the most commonly occurring species out of the fourteen species isolated from the soil. *F. camptoceras, F. dimerum, F. sporotrichioides* and *F. tricinctum* were recorded for the first time in Southern Indian soils, of these *F. sporotrichioides* and *F. tricinctum* are new records for India.

F. avenaceum, F. camptoceras, F. chlamydosporum, F. dimerum, F. poae, F. scripi, F. semitectum, F. sporotrichioides and *F. tricinctum* were nonpathogenic on cotton and pigeonpea, whilst *F. culmorum, F. oxysporum* and *F. solani* comprised pathogenic and non-pathogenic strains; a number of transitional forms were observed between the virulent and avirulent isolates pathogenic on cotton and pigeonpea, indicating that Fusaria occur in soils in a multiplicity of pathogenic forms. In certain strains of the highly specialised 'wilt' Fusaria, *F. udum* and *F. vasinfectum* host selectivity was observed, whereas many other isolates were non-specific to the host. The significance of these results in the taxonomy of Fusaria is discussed.

Many of the isolates were capable of causing disease reaction in the host when present in soil either individually or in combination; mixing two isolates resulted either in synergism and augmentation in pathogenicity or in antagonism and decrease in infection.

100. **Bhuvaneswari, K., & Sulochana, C. B.:** Assay of root exudates. *Curr. Sci.,* **24**: 376-77, 1955.

A new technique suitable for growing seedlings under controlled conditions in natural soil and obtaining root exudates produced *in situ* without injury to the root system is described.

101. **Subramanian, C. V.:** Fungi Imperfecti from Madras—VII. *Proc. Indian Acad. Sci.*, B, 42: 283-92, 1955.

In this paper three new species of Fungi Imperfecti collected from the Nilgiris are described: *Arthrobotryum coonoorense* on living leaves of *Thysanolaena maxima, Chloridium indicum* on dead leaves of a palm and of *Phoenix canariensis*, and *Dendryphion digitatum* on dead stems. Two other fungi are recorded from India for the first time, viz., *Pseudocamptoum fasciculatum* (Cke. & Mass.) Mason and *Septonema harknessii* (Ellis) Hughes.

102. **Subramanian, C. V.:** Some species of *Periconia* from India. *J. Indian bot. Soc.*, 34: 339-61, 1955.

This paper is a systematic account of Indian species of *Periconia*. Twelve species of this genus are recorded in this paper. Of these, six are described as new to science: *P. narsapurensis* on dead wood, from Narsapur, Hyderabad-Deccan; *P. obliqua* on dead bamboo from Madras; *P. kambakkamensis* on dead stem of bamboo, from Kambakkam Hills, Madras State; *P. madreeya* on dead culms of *Cynodon dactylon* from Madras; *P. tirupatiensis* on dead leaf rachis of *Phoenix* sp. from Tirumalai Hills, Andhra State; and *P. clitoriae* on dead stems of *Clitoria ternatea* from Madras. The other six species are *P. byssoides, P. cookei, P. minutissima, P. paludosa, P. hispidula*, and *P. laminella* and are being recorded for the first time from this country. A key to the identification of the Indian species of *Periconia* is also given.

103. **Ramakrishnan, K.:** Ascomycetes from South India—III. *Proc. Indian Acad. Sci.*, B, 42: 249-57, 1955.

The following ten fungi are described: *Anthostomella hibisci* nov. sp. *Amphisphaeria lantanae* nov. sp., *Ceratosphaeria crossandrae* nov. sp., *Didymosphaeria bambusicola* v. Hohn., *Hypodermella rhamni* nov. sp., *Melanopsamma indica* nov. sp., *Metasphaeria raimundoi* Rehm, *Microcyclus phoebes* nov. sp., *Phyllachora cyperi* Rehm, and *Phyllachora minuta* P. Henn.

104. **Lakshminarayanan, K.:** Role of cystine chelation in the mechanism of *Fusarium* wilt of cotton. *Experientia*, 11; 388-90, 1955.

Extensive chromatographic studies on the distribution of α-amino constituents in roots, shoots and leaves of resistant and susceptible varieties of cotton revealed the presence of cystine in the resistant ones while it was absent in the susceptible ones. Cystine was found to protect cut shoots of susceptible cotton against *in vitro* toxaemia produced by dialysed culture filtrate of *F. vasinfectum* at an optimum concentration of 10^{-4}M in presence of ferric iron. The possible role of cystine in the mechanism of wilt resistance in cotton is discussed.

Madras University : Department of Zoology

Abstracts of Papers Published in 1955

53. **Gnanamuthu, C. P.:** *Chonisosphaera indica,* a copepod parasitic on the crab *Neptunus Sp. Parasitology,* 44: 371-378, 1954.

Full description of this new species which occurs among the egg masses of the crabs is given.

54. **Gnanamuthu, C. P.:** Biology and Parapsychology. *J. Madras Univ.* A, 27: 1-7.

The analytical method of the physical sciences has not been found so helpful in understanding biological phenomena, for organisms are psychophysical systems. The doctrine of organicism has been promulgated to conserve concepts peculiar to the vital sciences. In trying to trace the spontaneous creative indeterminacy of organisms, to explain how vital organisations could regulate growth and differentiation and rise up several levels and boast of a history in defiance of entropy, to understand how an individuality or personality is maintained in spite of disruptive forces—several hypotheses have been put forward. But the recent findings of parapsychologists appear to indicate a field beyond the limits of space-time-mass we have been familiar with so far. They present phenomena of a nonphysical character and defy physical explanation. The hypothesis that the regulating forces of the living organism and the mental system of the humans may belong to the same continuum and that there is a psychical mechanism distinct and independent of the human knower and his brain.

55. **Krishnan, G.** The Epicuticle of an arachnid *Palamneus swammerdami, Quart. J. Micr. Sci.* 95: 371-381.

The chemical composition and mode of hardening of the epicuticle is described and shown to be different from the condition found in insect epicuticle.

56. **Krishnan, G.:** Nature of the cuticle of Pycnogonida. *Nature. Lond.,* 175: 904.

The cuticle of the pycnogonid *Propallene kempi* is described. It has been shown that it recalls the features found in the arachnids.

57. **Krishnan, G.:** *et al.* Occurrence of chitin in the epicuticle of *Palamneus swammerdami. Nature, Lond.,* 175: 557-558.

It is shown that unlike the cuticle of the arthropods so far studied, in this type epicuticle gives evidence of the presence of chitin, which is an unusual feature.

58. **Krishnaswamy, S.:** Life history of the Psammophilous copepod, *Leptastacus euryhalinus*. *J. Madras Univ.* B, **26**: 353-359.

The naupliar and copepodite stages are described fully. Some notes on the ecology and bionomics have also been added.

59. **Sebastian, V. O.:** Dedifferentiation in the colony of *Polyclinum indicum*. *J. Madras Univ.*, B, **24**: 363-371, 1954.

Colonies of this ascidian were kept in a limited volume of sea water without giving any change. Adverse conditions like shortage of food and oxygen induced regression of the thorax and abdomen, and the post-abdomen formed a bud. The colonies recovered only if they are changed to fresh sea water within five days. Only the buds which detach from the abdomen are able to redifferentiate. The decay of the test affects the whole colony and healthy life is possible only if a fresher test is secreted.

60. **Sebastian, V. O.:** *Perophosa listeri indica* var *nova*. A new ascidian from the Madras coast of India. *Zool. Anz.*, **154**: 266-268.

A new variety of *Perophora listeri* is described fully.

61. **Pampapathi Rao, K.:** Morphogenesis during regeneration in an Enteropneust. *J. Anim. Morphol. Physiol.* **1**: 1-8.

The process of regeneration in the adult *Ptychodera flava* has been studied. Histogenesis and organogenesis during regeneration are similar to these processes in ontogeny, although a remarkable exception is the formation of the stomochords from the epidermis due to metaplasia. The great similarity between ontogeny and regeneration suggests that regeneration is a primary function of living matter.

62. **Ramaswamy, T. S.:** Fat contents of the Red Mullet *Upenus indicus* (Shaw). *J. Madras Univ.*, B, B, **25**: 115-122.

The fluctuations in the fat contents of the whole fish are not only related to the quantity of food consumed but also to the composition and fat quality. The fat contents of the different storage depots are interrelated both in storage and depletion, when the gonads mature, the fat required by them appear to be withdrawn from the fat depots.

63. **Daniel, A.:** Effect of Copper sulphate and Mercuric chloride on Barnacle larvae. *J. Timber Dryer's and Preserver's Assn. India.*, **2**: 9-14.

Very low concentrations of both mercury and copper were found to be lethal for the nauplii and cyprids of 3 species of Madras barnacles. The resistance of the cyprids decreases with increase in age and appears to interfere with normal processes of development.

64. **Daniel, A.** Gregarious attraction as a factor influencing the settlement of Barnacle cyprids. *J. Madras Univ. B,* 23: 97-107.

The barnacles at Madras are susceptible to gregarious attraction as in temperate waters. It is directly proportional to the number of barnacles already settled and inversely proportional to the distance from them. It is suggested that the gregarious attraction may be due to to some biochemical factor.

65. **Daniel, A.:** Primary film as a factor in settlement of marine foulers. *J. Madras Univ.,* B, 25: 188-200.

Results of experiments conducted on the settlement of sessile organisms are represented. It is found that the formation of the primary film is requisite for the settlement of the sessile organisms. The composition of the primary film is also given.

66. **George Cherian, A.:** Cutaneous and pulmonary exchange of gases in the frog. *J. Madras Univ., B,* 24, 355-362, 1952.

The respiratory exchange through the skin and lungs in the frog during the normal respiration has been estimated. It is found that the skin takes in 0·023037 cc/gm/hr of oxygen while the lungs take in 0·17247 cc/gm/hr, when the frog remains under water for 15 minutes, there is a slow reduction in the rate of O_2 intake through the skin. When forced to remain under water for seven more minutes it is asphyxiated.

67. **Muthu, M.S.:** Unusual lowering of salinity in the Madras coastal area and its effect on the plankton. *Curr. Sci.,* 24; 87-89.

The effect of sudden lowering of the salinity on the phyto-and Zoo-plankton has been observed. The tolerance of salinity changes by various planktons are given.

68. **Krishna Kumaran, A.:** Ecdysial mechanism in a decapod, *Penaeus indicus. Curr. Sci.,* 23: 403-405, 1954.

The changes in the chitogenous epithelium during ecdysis have been studied. It is observed that the cells of the chitogenous epithelium increase in numbers before moulting and probably migrate inwards to give rise to new epithelium of the succeeding moult.

69. **Balakrishnan Nair, N.:** The digestive enzymes of *Bankia indica, Curr. Sci.,* 24: 126-127.

The digestive enzyme system of *Bankia indica* consists of a strong amylase, glycogenase and cellulase in the crystalline style and lipolytic enzymes and protease present in the digestive diverticula. The optimum PH ranges are also indicated.

70. **Balakrishnan Nair, N.:** On a new species of shipworm of the sub-genus *Neobankia* from Madras. *J. Madras Univ.,* B, 25: 109-113, 1955.

A new shipworm, *Bankia (Neobankia) lineata* is described from Madras.

71. **Balakrishnan Nair, N.:** Cellulase activity of the crystalline style of the wood-boring pelecypod *Bankia indica* Nair, *Curr. Sci.,* 24: 201.

Extracts from crystalline style were tested for cellulase by Newell's method. The extent of digestion was also verified by estimating the sugars at various intervals. An analysis of the end products found by enzymic hydrolysis of cellulose revealed that cellobiase and glucose are the end products. It is suggested that the cellulase liberated by the crystalline style hydrolyses the cellulose into cellobiase first, which, is further converted into glucose by the cellobiase of the digestive diverticula.

Madras University : Department of Biochemistry

Abstracts of Papers Published in 1955

61. **Shanmugasundaram, E. R. B. & Sarma, P. S.:** Inter-relationship among Vitamins and Amino Acids: Part III—Influence of Protein Hydrolysates on the Biological Synthesis of Nicotinic Acid from Tryptophane in *Neurospora crassa*. *J. sci. industr. Res.* **14-C**,: 105.

The influence of some protein hydrolysates on the utilisation of tryptophane and its metabolites by a nicotinic acid dependent strain of *Neurospora crassa* was studied. The protein hydrolysates inhibited the utilisation of tryptophane, kynurenine and 3-hydroxykynurenine, whereas they had no influence on the utilisation of 3-hydroxyanthranilic acid and nicotinic acid. It is suggested that certain amino acids in the hydrolysate inhibit the enzyme systems responsible for the conversion of tryptophane to 3-hydroxy anthranilic acid and the pellagara effect of corn may be due in part, to the blocking in this manner of the formation of nicotinic acid from 3-hydroxykynurenine.

62. **Moudgal, N. R., Srinivasan, V., & Sarma, P. S.:** Iodination of some Proteins and Defatted Seed Cakes. *J. sci. industr. Res.*, **14-C**: 78.

Various animal and vegetable proteins have been iodinated in bicarbonate medium with a view to study their suitability as basic material for preparing highly active iodoproteins. The tyrosine availability for iodination, the extent of thyroxine formation and the diiodotyrosine availability for coupling to form thyroxine have been studied in these proteins.

63. **Ramachandran, S., & Sarma, P. S.:** Paper Chromatography and Radioautography of Amylase, *Curr. Sci.*, 24: 235.

In order to test whether the enzyme amylase is secreted as enzyme phospholipid complex or lipoprotein, paper chromatography and radioautography of the amylase synthesised and secreted into the incubation medium by pigeon pancreas slices in presence of radio active phosphorous has been carried out. The results obtained showed the presence of radioactive phosphorous in the amylase synthesised and secreted into the medium.

64. **Shanmugasundaram, E. R. B., & Sarma, P. S.:** Inter-relationship among Vitamins and Amino Acids: Part IV: Role of Folic Acid and PABA in tryptophane Metabolism in *Neurospora crassa*. *J. sci industr. Res.*, **14-C**: 117.

Sulphanilamide inhibits the utilisation of tryptophane by a nicotinic acid dependent strain of *Neurospora crassa* and this inhibition is overcome by folic acid or PABA suggesting thereby that folic acid or PABA may be involved in tryptophane metabolism. As the utilisation of other metabolites like formylkynurenine, kynurenine, 3-hydroxykynurenine and 3-hydroxyanthranilic acid and nicotinic acid is not affected by sulphanilamide, it is suggested that folic acid or PABA may be directly or indirectly concerned with tryptophane "peroxidase-oxidase" system.

65. **Sivaramakrishnan, V. M., & Sarma, P. S.:** The Influence of Thiamine on Nitrogen Metabolism, *Bio. chem. Biophys. Acta.*, **18**: 153.

Neopyrithiamine, an antivitamin of thiamine, added to the growth medium of germinating green gram seeds produces a marked fall in asparagine level and simultaneously a considerable accumulation of free ammonia while the the glutamine level remains practically constant. These changes are reversed partially by thiamine and completely by cocarboxylase. The results obtained suggest that neopyrithiamine is a specific antivitamin for plant also and that thiamine exerts a profound influence on nitrogen metabolism. Evidence for a requirement of thiamine for the metabolism of glutamic acid has been obtained in rats also. While normal rats tolerated well an intraperitoneal injection of glutamic acid, neopyrithiamine treated rats reacted violently and developed within one hour of the injection all the symptoms of acute thiamine deficiency probably due to rapid utilisation and hence exhaustion of all available thiamine for the metabolism of glutamic acid injected.

66. **Sivarama Sastry, K., & Sarma, P. S.:** The Role of Thiamine in the Biosynthesis of Ascorbic Acid in the Rat. *Curr. Sci.*, **24**: 298.

In thiamine deficient rats, it was found that they showed a decreased capacity to utilise glucorono-gamma-lactone (glucurone) for biosynthesis of ascorbic acid. It was also found that less of glucurone was excreted by thiamine deficient rats as compared to normal ones, when both were injected with the same amount of glucurone. It was suggested that this may reflect an increased catabolism of glucurone in thiamine deficient rats.

67. **Ramachandran, S., & Sarma, P. S.:** Relationship between Amylase Synthesis and Uptake of P^{32} by Phospholipids in Pigeon Pancreas Slices. *J. sci. industr. Res.*, **14-C**: 168.

In vitro studies using pigeon pancreas slices were made to determine whether there is a correlation between inositol phospholipid synthesis, uptake of radioactive phosphorous (P^{32}) by phospholipids and amylase synthesis and also to confirm the role of CoA in the synthesis of phospholipid. Omega-methyl pantothenic acid, an antimetabolite of pantothenic acid was used. It is found that the antivitamin inhibits both amylase activity as well as the

synthesis of inositol phospholipid and the turn over of phospholipids. It is also observed that there exists a close relationship between inositol phospholipid formation and amylase synthesis giving conclusive evidence for the role of inositol in the activity of α-amylase.

68. **Shanmugasundaram, E. R. B., Sitarama Acharya, U., & Sarma, P. S.:** Influence of "B" Vitamins on the Inhibition by Casein Hydrolysate of Tryptophane Utilisation in *Neurospora crassa*. *Curr. Sci.*, **24**: 268.

Using a nicotinic acid dependent strain of *Neurospora crassa* it is found that casein hydrolysate inhibition of tryptophane utilisation is overcome by certain "B" vitamins like thiamine, pyridoxine, folic acid and choline, whereas the other vitamins of the "B" group do not have any effect. The vitamins when present alone in the medium do not exert any influence on the utilisation of tryptophane.

69. **Sivaramakrishnan, V. M., & Sarma, P. S.:** The Inhibition by Sulphanilamide of the Metabolism of Histidine in Germinating Seeds. *Curr. Sci.*, **24**: 330.

Using histidine labelled with C^{14} in the α-carbon atom evidence for a moderate degradation of histidine in green gram has been obtained. There is conversion of histidine to glutamic acid during germination. Sulfanilamide inhibits this conversion producing a greater retention of radioactivity in histidine and a lesser incorporation into glutamic acid. A comparison of the activities in histidine and glutamic acid during germination and sulfanilamide treatment suggests that the conversion to glutamic acid may not be the major pathway of histidine degradation in this species.

70. **Moudgal, N. R., Srinivasan, V., & Sarma, P. S.:** Effect of Thyroid Hormone on the Conjunction of Benzoyl Glucuronide in the Rat. *J. sci. industr. Res.* **14-C**: 191.

Thyroid hormone is found to effect the conjunction of glucuronic acid in that a greater amount of glucuronide than normal is excreted in the hypothyroidal condition whereas the amount of glucuronic acid conjugated is decreased in hypothyroid condition when compared with normal. The probable reasons for this are discussed.

71. **Sivaramakrishnan, V. M., & Sarma, P. S.:** The Metabolism of Glutamic Acid in Germinating Seeds. *Biochem. J.* **62**: 132.

With the help of uniformly C^{14} labelled glutamic acid, the metabolism of glutamic acid in germinating green gram seeds has been studied. A rapid degradation of glutamic acid has been noted along with strong presumptive evidence for a synthesis of glutamic acid during germination. The major

portion of the radioactivity lost during germination is recovered in the carbon-dioxide respired off. Aspartic acid and asparagine are among the important end products of glutamic acid degradation. There is a slight conversion of glutamic acid to proline and arginine. With the help of uniformly C^{14} labelled glucose, evidence for the synthesis of glutamic acid from carbohydrates during germination has been obtained. The rapid degradation and the rapid synthesis of glutamic acid noted during germination suggests that this amino acid is highly metabolically active in this species.

72. **Shanmugasundaram, E. R. B., & Sarma, P. S.:** Inter-relationship Among Vitamins & Amino Acids: Part V—Role of Biotin in Tryptophane Metabolism Studied in Rats. *J. sci. industr. Res.* **14-C:** 193.

Paper chromatographic detection of tryptophane metabolites was made in the urine of biotin deficient and biotin fed rats. No normal tryptophane metabolite was found to be excreted in the urine of biotin deficient rat. But the amounts of N'-methyl nicotinamide and nicotinic acid excreted in the urine of deficient rats were considerably low when compared to normal rats. The probable role of biotin is discussed.

73. **Srinivasan, V., Moudgal, N. R., & Sarma, P. S.:** Effect of Thyroxine and Thyroglobulin in Rice Moth Larvae. *Science.* **122:** 644.

It has been observed that thyroxine when added at a level of 0·75γ/gm. of the diet accelarates the growth rate and metamorphosis of rice moth larva. The oxygen consumption of the larva is enhanced by feeding a supplement of thyroxine. Thyroglobulin had no effect on the growth or the metamorphosis of the larva.

74. **Ramachandran, L. K., & Sarma, P. S.:** Effect of Added Diiodotyrosine on the Incubation Step in the Iodination of Proteins. *J. Sci. industr. Res.* **14-C:** 196.

Addition of free diiodotyrosine to proteins during the incubation step of iodination has been shown to increase their thyroxine content. The present investigation lends support to the theory that there exists in proteins certain diiodotyrosine moities which are not available for coupling among themselves to form thyroxine due to steric hindrance. The addition of free diiodotyrosine, however, brings about coupling with these non-available diiodotyrosine moities and thus increases the thyroxine content of proteins.

75. **Sivaramakrishnan, V. M., & Sarma, P. S.:** Biochemical Technique—A Review. *Ann. Rev. biochem. Res. India,* **25:** 1.

Work done in India using various biochemical techniques like (a) Isotope-tracer technique (b) Paper chromatography and (c) Inhibition analysis has been reviewed with 75 references.

Madras University : Department of Physical Chemistry

Abstracts of Papers Published in 1955

1. **Santhappa, M., & Mahadeva Iyer, V.:** Rates of Initiation in the Polymerization of the Methyl acrylate. *Curr. Sci.*, **24**; 173, 1955.

General nature of polymerization of methyl acrylate under various conditions and evaluation of rates of initiation and chain transfer constants for the monomer and catalysts, benzoyl peroxide at 55-70°C., have been dealt with. The results indicate the unitary nature of the Catalyst efficiency, first order kinetics of the overall rate, bimolecular nature of the termination processes etc.

2. **Subramanyam, R. V. & Santhappa, M.:** Citrate Radical Ion Polymerization of Methyl methacrylate. *Curr. Sci.*, **24**: 229, 1955.

The system ferric citrate ion-pair-methylmethacrylate irradiated with ultraviolet wavelength $> 300 m\mu$ induces polymerization. Results for rates of ferrous ion production, monomer disappearance and degrees of polymerization with different concentrations of the monomer are given. Molecular weight averages of unfractionated polymethylmethacrylate ranged from Ca-200,000 to 600,000.

3. **Vaidyanathan, V. S., Chaithanyan, C., and Santhappa, M.:** Nature of Initiation in Vinyl Polymerizations. *Curr. Sci.*, **24**: 256, 1955.

Nature of reactions of primary free radicals from a peroxide catalyst with special reference to the recombination reactions as well as initiation of polymerization of vinyl monomers has been discussed thread-bare by a study of the relationship of reciprocal degree of polymerization and (catalyst$^{1}/_{2}$/monomer) or (catalyst/monomer)$^{1}/_{2}$. Styrene and vinyl acetate were used as monomers while benzoyl peroxide and methyl ethyl ketone peroxide as catalysts.

4. **Mahadevan, V., & Santhappa, M.:** Rates of Initiation & Chain transfer Constants in the Polymerization of methyl acrylate., *Die Makromolekulare Chemie*, Heft, 2, **16**; 119, 1955.

By a study of bulk polymerization of methyl acrylate at 55°—75° C. with benzoyl peroxide, ditertiary butyl peroxide, methyl ethyl ketone peroxide and tertiary butyl hydroperoxide as catalysts, rates of initiation, chain transfer constants for the monomer and the catalyst have been evaluated. Determination of temperature coefficients for all the rate constants have been made. Values for the catalyst efficiencies and thermal rate constants for initiation are given.

5. **Vaidyanathan, V. S., & Santhappa, M.:** Chain Transfer Reactions and Nature of Initiation in the Polymerization of Styrene, *Die Makromolekulare Chemie,* Heft, 2, 16: 140, 1955.

Chain transfer reaction of styrene in acids, alcohols at 60°—80° C., have been studied. Temperature coefficient determinations of transfer constants have indicated the positive effect with acids and irreproducibility with alcohols. From a study of overall rates with the (solvent/monomer) ratios the inhibitory nature of the solvent has been concluded. The relative importance of the primary radicals for initiation and recombination, from benzoyl peroxide, methyl ethyl ketone peroxide, Ditertiarybutylperoxide and tertiarybutylhydroperoxide has been inferred by employing them to catalyse the polymerization of styrene at 80—100° C. From the overall rates and degrees of polymerization the rates of catalytic initiations in solution polymerization of styrene have been evaluated.

Madras University : Department of Physics

Abstracts of Papers Published in 1955

BIOPHYSICS

1. **Ramachandran, G. N., & Kartha, G.:** Structure of Collagen *Nature, Lond.,* **176**: 593, 1955.

A revised structure of collagen is put forward which is much superior to the one proposed earlier. The structure consists of three intertwining coiled coils of polypeptide chains. The individual helices have 10 residues in 3 turns, while the major helix on which they are all further coiled makes one turn in 30 residues in the opposite direction. As a consequence, every third residue occurs in the same configuration as far as the backbone is concerned. Two strong hydrogen bonds are formed between the chains for every three residues. The structure is stabilised by means of cross-links between the neighbouring triple chain protofibrils. The cross-linking through hydroxyproline residues are short and straight and explains the relationship between thermal stability and hydroxyproline content. The structure fits x-ray and infra-red data and explains the amino-acid composition. A suggestion is given as to the origin of the long spacing.

2. **Ramachandran, G. N.:** Infra-red Spectrum and Structure of Collagen: *J. Chem. Phys.,* **23**: 600, 1955.

The 3-10 coiled coil structure of collagen is shown to be in good accord with the infra-red data of Sutherland *et al.*

3. **Ramachandran, G. N., & Ambady, G. K.:** Oriented Crystallisation of Inorganic Salts in Collagen. *Experientia,* **11**: 343, 1955.

When stretched collagen fibres are kept in an alkaline solution of inorganic salts and then dried, the salts crystallise with one of its axes parallel to the fibre axis. This occurs if the period along this axis lies between 3·2 and 3·75 A or a multiple thereof.

4. **Ramachandran, G. N., & Kartha, G.:** Studies on Collagen: Part I: Structure of Collagen Group of Proteins. *Proc. Indian Acad. Sci.,* **A, 42**: 215-34, 1955.

A fuller account of the article No. 1. The consequences of the structure with respect to the properties of collagen are discussed in detail.

5. **Krishnan, G., Ramachandran G. N., & Santanam, M. S.:** Occurrence of Chitin in the Epicuticle of an Arachnid: *Palamneus Swammerdami. Nature, Lond.,* 176: 557, 1955.

The x-ray diffraction patterns of the epicuticle of *Palamneus Swammerdami* indicated the presence of chitin in the epicuticle. The same was confirmed by hydrolysing the epicuticlar material and estimating the liberated glucose amine by the method of Elson and Morgan. A similar pattern was given by the epicuticle of *Scolopendra* also.

6. **Santanam, M. S.:** Studies on Cuticles of Arthropods. *Proc. Indian Acad. Sci.,* A, 42: 142, 1955.

The paper deals with a study of cuticles of a number of species of Arthropods by x-ray and chemical methods. In all the animals studied, the endocuticular constitution was found to be the same conforming to the chitin-protein complex observed by Fraenkel and Rudall. The epicuticle on the other hand showed wide variations. In Arachnida, and Myriopoda it was found to consist largely of chitin which was entirely unexpected. In other species no chitin was present in the epicuticle in agreement with the current ideas of the constitution of the epicuticle. The necessity for revision of some of the current ideas regarding the homology of the epicuticle is indicated and the nature of association between protein and chitin in the epicuticular material is also discussed.

CRYSTAL PHYSICS

7. **Chandrasekharan, K. S.:** Influence of the Degree of Perfection of a Crystal on the Intensity of Bragg Reflection—Part I. Measurements with Calcite and Rock Salt. *Proc. Indian Acad. Sci.,* A, 41: 185, 1955.

A Geiger Counter Spectrometer incorporating a polariser-monochromator, integrating device and electronic recording equipment are described and measurements of integrated intensities of reflections in different orders from calcite and rock salt specimens are reported. These are compared against the theoretical values with a view to assess the nature of the surface under different conditions of treatment.

8. **Chandrasekharan K. S.:** Bragg Reflection of Polarised X-rays from a Perfect Absorbing Crystal. *Acta cryst. Camb.* 8: 361, 1955.

On the basis of the dynamical theory of x-ray reflection Hirsch and Ramachandran have worked out semi-empirical formulae for the variation of the integrated intensity of reflection with the azimuth of polarisation of the x-ray beam for a crystal taking absorption into account. This is verified

using a Geiger counter spectrometer assembly, for reflections from the cleavage face of a calcite crystal.

9. **Lonappan, M. A.:** Thermal Expansion of Potassium Nitrate. *Proc. Indian Acad. Sci.*, A, 41: 239, 1955.

The principal expansions, determined by an x-ray method, in the range 30° to 100°C. are α_{11} (b) = 22·0, α_{22} (a) = 23·5, α_{33} (c) = 183 × 10^{-6} The direction of greatest expansion is normal to the plane of the O_3 group. The approximate validity of the Grüneisen relation is tested by calculating the compressibility from a knowledge of the variation of the Raman frequency with temperature.

10. **Lonappan, M. A.:** Thermal Expansions of Boric Acid. *Proc. Indian Acad. Sci.*, A, 42: 10, 1951.

The principal expansion coefficients and the orientation of the ellipsoid of expansion have been determined by an x-ray method for the triclinic crystal, orthoboric acid, for the range 30 to 80°c. The anisotropy of expansion is extremely large, the maximum and minimum values being 256 and −4, × 10^{-6}. The direction of the maximum expansion is close to the normal to the O_3 groups. This is the first time that the thermal expansion of a triclinic crystal has been fully studied by an x-ray method.

11. **Amirthalingam, V., & Ramachandran, G. N.:** Structure of DL-Aspartic Acid. *Curr. Sci.*, 24: 294, 1955

The main features of the structure of this monoclinic crystal have been worked out. The molecular length is nearly parallel to the long c axis. The molecule has the zwitterion structure and one of three hydrogens is internally hydrogen-bonded to one of the carboxyl oxygen atoms, as has been suggested from chemical considerations.

STOCHASTIC THEORY

12. **Alladi Ramakrishnan & Mathews, P. M.:** Straggling of the Range of Fast Particles as a Stochastic Processes. *Proc. Indian Acad. Sci.*, A, 41: 1955.

Numerical results relating to straggling of fast particles passing through matter are derived on the basis of a model in which ionisation loss in a radiative collision is a constant fraction of the energy of the particle. The probability distribution of the range is presented in graphs.

13. 14. **Alladi Ramakrishnan:** Phenomenological Interpretation of the Integrals of a Class of Random Functions, I & II. *Proc. Indian Acad Sci.*, A, 1955.

In these two papers an interpretation of integrals of random functions is formulated. The concept of inverse trajectory of stochastic processes represented by such integrals is introduced. Based on this concept a simple operational calculus for a class of random functions associated with the Poisson distribution is devised.

15. **Alladi Ramakrishnan:** On Integrals of Random Functions. *Proc. Neth. Acad. Sci.*, 1955.

The probability frequency function (p. f. f.) of integrals of a class of random functions is obtained by writing an integral equation for the p. f. f. by a simple new device.

16. **Alladi Ramakrishnan:** Inverse Probability and Evolutionary Stochastic Processes. *Proc. Indian Acad. Sci.*, A, 1955.

It is shown that the standard stochastic equations for Markoff processes progressing with t are reversible in t with the essential difference that the process of tracing back the process terminates at a certain point known as the "origin" of the process.

17. **Mathews, P. M., & Srinivasan, S. K.:** Stochastic Processes Associated with Integrals of a Class of Random Functions. *Proc. Nat. Inst. Sci. India.* (In Press.)

The Laplace transform solution of the nth interated integral of a random function representing a Poisson process is obtained. Possible applications in Physics and Electrical Engineering are suggested.

ASTROPHYSICS

18. **Alladi Ramakrishnan & Srinivasan, S. K.:** Correlation Problems in the Theory of Fluctuations in Brightness of Milky Way. *Astrophys. J.* (In Press.)

The problem of fluctuations in brightness of the Milky Way is studied from a new point of view—correlation between the contribution to brightness from different parts of the astrophysical system. Besides extending Munch's results, relevance to the phenomenological theory of stochastic integration is pointed out.

Madras University : Department of Mathematics

Abstracts of Papers Published in 1955

1. **Krishnan, V. S.:** A Note on Semi Uniform Spaces. *J. Madras Univ.*, B, 25: 1955.

A family F of surroundings of the diagonal of the cartesian product set R^2 gives to R a semi uniform structure, if each A in F contains the relational product B.B of some B in F. The topological or neighbourhood structure of such a space is shown here to be merely that of a v-space of M. Fréchet. The existence of a total family of upper semi-continuous functions gives another characterisation of the space.

2. **Krishnan, V. S.:** Additivity and symmetry for generalised uniform structures and characterisations of semi-uniform structures. *J. Madras Univ.*, B, 25; 2, 1955.

A family of surroundings of the diagonal of the cartesian product R^2 gives a generalised uniform structure (or gu structure); it becomes a semi-uniform (or su) structure if each surrounding contains the relational product with itself of some surrounding. To such a gu or su structure can be uniquely associated certain additive, or symmetric structures of the same sort. Treating these associations as operators on types of c-structures, where the gu or su structures are treated as the c-structures with the uniformly continuous mappings as c-homomorphisms, the relations of these to other operations on c-structure-types already defined by the theory of such structures (in 'Closure operations in c-structures', Kon. Ned Akad. Wet., Proceedings, A, 56, no. 4), is investigated, and characterisations are obtained for the su structures with or without the conditions of additivity or symmetry in terms of semi-écart structures of suitable types. A generalisation of the process of imbedding the semi-group with order and uniformity formed by the positive rationals (or reals) in the ordered symmetric uniform group of all rationals (or reals) is worked out also.

Madras University: Department of Geology & Geophysics

Abstracts of Papers Published in 1955

1. **Naidu, P. R. J.:** Interference Figures in Reflected Polarized Light. *Curr. Sci.*, **24**: 47-48, 1955.

Interference Figures in reflected polarized light, reported so far only from opaque minerals, have also been observed in minerals transparent in thin sections. The studied minerals have been grouped under four heads and the phenomenon explained.

2. **Naidu, P. R. J.:** Measurement of Extinction Angles in Hornblendes which Show Strong Absorption. *Curr. Sci.* **24**: 154-55, 1955.

Two methods, eliminating difficulties arising out of strong absorption parallel to Z in hornblendes to determine extinction angles, have been outlined. One method consists in locating the optic axes and the optic axial plane while in the other, the Biot-Fresnel law of extinction is employed.

3. **Naidu, P. R. J.:** Minerals of Charnockites from India. *Schweiz. min. petrogr. Mitt.*, **34**: 204-280, 1955.

The paper deals with optical and chemical characters of the minerals contained in the charnockites of India. The results are treated under the following headings: (1) The determination of the plagioclase felspars (a) by the Fedorow method (b) by the single variation method (2) Perthitic felspars (3) Mafic minerals: Hypersthene, clinopyroxene, green and blue amphiboles, mica, garnet and (4) the chemical relationship of these minerals to the rocks in which they occur. The micrometric analyses of some of the examined thin slides of the rock specimens are given in appendix I; in appendix II the petrofabric analyses of these rock types are shown.

4. **Ramanathan, S.:** Vogesites and Noritic Olivine Dolerites from Salem and Dodkanya. *J. Madras Univ.* B, **25**; 29-54, 1955.

Five dyke rocks, two from Salem and the rest from Dodkanya, Mysore, have been chemically analysed and the optical characters of their minerals investigated. The dykes of Salem (Vogesites) seem to be related to a shonkinitic magma while those of Mysore (noritic olivine dolerites) are related to a gabbroid magma.

5. **Babu, S. K.:** Migmatisation in Kattriguppe Quarry, Bangalore Dist., Mysore State. *J. Madras Univ.* B, **25**: 129-146, 1955.

The geochemical changes of the rocks from Kattriguppe have been dealt with after the method of Reynolds. The effect of the geochemical changes has been to produce rocks of normal igneous series by the process of mechanical pulverisation and reciprocal reaction.

6. **Babu, S. K.:** Heavy Accessories of the Granites and Gneisses of Chamundi Hills, Mysore. *J. Madras Univ.*, B, **25**: 291-300, 1955.

The frequencies of the heavy minerals of Chamundi granites are represented by Histograms and also after the method of Stark and Barnes. The association of biotite-garnet places Chamundi Granite at a higher grade of metamorphism than Cuddapah granites.

7. **Raghavan. V. M.:** Heavy Mineral Suites in the Granite Rocks of Jalarpet. *J. Madras Univ.*, B, **25**: 147-152, 1955.

The Index figure of the heavy mineral residue of the granite rocks of Jalarpet indicates uniform distribution of the minerals. Apatite, Sphene, and Epidote, however, are more abundant in the hornblende bearing granites than in the biotite-bearing types.

8. **Balasubrahmanyan, M. N.:** The Association and Genesis of the Wollastonite and Scapolite Bearing Rocks of Sankaridrug, Salem Dist. *J. Madras Univ.* B, **25**: 153-65, 1955.

The contact metamorphic assemblages developed in the calc-bands of Sankaridrug are discussed in the light of Eskola's facies. The geological and tectonic relationship of the anorthite gneiss of Sittampundi to the calc-gneisses of Sankaridrug is suggested.

9. **Balasubrahmanyan, M. N.:** Some Minerals from the Calc-band of Sankaridrug, Salem Dist. *J. Madras Univ.*, B, **25**: 263-70. 1955.

A Tremolite, a clino-pyroxene and a Wollastonite have been studied optically and chemically. The Wollastonite is free from alumina while the clino-pyroxene is alumina-rich.

10. **Balasubrahmanyan, M. N.:** Tectonics of the Granites, Gneisses and Migmatites of Sankaridrug. *J. Madras Univ.*, B, **25**: 255-61, 1955.

The megafabrics of the Sankaridrug Granite mass has been studied along the lines of Cloos. The petrofabrics of a gneiss and a migmatite is also given.

11. **Nehru, C. E.:** Two amphiboles from the Anorthite and Biotite Gneisses of Sittampundi, Salem Dist. *J. Madras Univ.*, B, **25**: 19-28, 1955.

An amphibole from anorthite gneiss and another from an adjoining biotite-gneiss have been chemically analysed and their optical characters determined. Their chemical and optical relationships to other analysed amphiboles are discussed.

12. **Nehru, C. E.:** Geology and Petrochemistry of the Anorthite Gneiss and Associated Rocks of Sittampundi, Salem Dist., *J. Madras Univ.*, B, **25**: 173-88, 1955.

The view has been put forward that the anorthite gneiss of Sittampundi and the Calc-gneiss of Sankaridrug form an anticline warped up by the intrusion of the granites of the area. The anorthite complex of Sittampundi represents a metamorphic facies of the eclogite and Pyroxene-hornfels grades. Original impure calcareous sediments and pyroxenite-peridotite intrusions are the units metamorphosed.

13. **Nehru, C. E.:** A Pyroxene from Sittampundi, Salem Dist. *J. Madras Univ.*, B, **25**: 167-72, 1955.

A clinopyroxene from Sittampundi is analysed and its optical characters determined. Its characters are compared with the pyroxenes of Adirondack anorthosite series and its origin discussed.

14. **Nehru, C. E.:** Tectonics of the Granites and Gneisses of Tiruchengodu, Salem Dist. *J. Madras Univ.*, B, **25**: 227-33, 1955.

From a study of the poles of joints in stereographic projection, it is concluded that the Tiruchengodu granite intruded as a dome. The petrofabric diagram of the C axes of the quartzes of the Granite and migmatite of this area correspond to Ia and IVc of the schematic diagram of Quartz axes as given by Fairbairn (1954). The conclusion is reached that the granites and the migmatites may have been once quartzites, which have been subjected to rheomorphism.

15. **Leelananda Rao, N.:** Further Work on the Dyke Rocks of Pallavaram, *J. Madras Univ.*, B, **25**: 323-39, 1955.

The optical and chemical work of the dyke rocks of Pallavaram has been studied further. The structural trend of the dykes in relation to the major joint directions of the area is also dealt with.

Madras University : Department of Chemical Engineering

Abstracts of Papers Published, 1954-55.

1. **Gopala Venkataraman & Laddha, G. S.:** Peanut Oil—Oleic Acid—Acetic Acid and Peanut Oil—Oleic Acid—Furfural Ternary Systems. *Industr. Engng. Chem.*, **47**: 1272-73, 1955.

In connection with a study of the extraction of fatty acids from fatty acid-vegetable oil solutions, complete equilibrium and phase distribution data have been obtained for the peanut oil—oleic acid—acetic acid and peanut oil —oleic acid—furfural systems at 40°C.

2. **Govinda Rau, M. A., & Subba Rau, M. G.:** Simple Apparatus for Refrigeration Experiments. *J. chem. Educ.*, **32**: 364, 1955.

Description, operation and line drawing of a household Freon Refrigeration Unit, modified for use as an experimental unit in engineering laboratories is given. The Paper gives a set of specimen data and sample calculation for refrigeration and heat pump operation.

3. **Subrahmanyan, S., & Madhavan Nair, A. P.:** Carbonisation of South Arcot Lignite at different temperatures, *J. Madras Univ.*, B, **24**: 385-392, 1954.

The proximate analysis of a sample of South Arcot Lignite was done and its calorific value determined. The low temperature carbonisation assay of the lignite was performed at different temperatures and the effects of the temperature and the rate of attainment of the temperature on yield of the products have been studied. The proximate analysis of its calorific value were carried out. The calorific value of the gas has also been obtained. Certain interesting conclusions have been drawn with regard to the influence of temperature on the yields of the products.

4. **Subrahmanyan, S., & Madhavan Nair, A. P.:** A Study of the Characteristics of the Low Temperature Tar obtained from South Arcot Lignite. *J. Madras Univ.*, B, **24**: 393-401, 1954.

A complete study of the low temperature tar obtained from the lignite at 600°C has been made. Besides a determination of the physical characteristics of the tar, the work comprises distillation of the tar into several fractions, alkali-extraction of the phenols followed by the fractionations of the phenols and of the washed oil, determination of the quantities of the distillates, estimation of naphthalene, anthracene, pure phenol and pyridine bases.

5. **Madhavan Nair, A. P., & Jagannadhaswamy, B.:** Active Carbon from South Arcot Lignite. *Curr. Sci.*, **24**; 75-76, **1955.**

An investigation of different methods of preparation of active carbon from lignite and a study of the absorptive properties of the products obtained have been described. Activating agents employed were steam (at various temperatures), calcium chloride, zinc chloride and phosphoric acid in various proportions. The absorptive powers were evaluated by means of the absorption of iodine, oxalic acid, methylene blue and malachite green as well as the decolourisation of molasses, cane and palm jaggery solutions. It was found that phosphoric acid was the best activating agent, the activating capacity of the other agents being in the order:—zinc chloride, calcium chloride and steam. The optimum temperature of activation was found to be 650°C.

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